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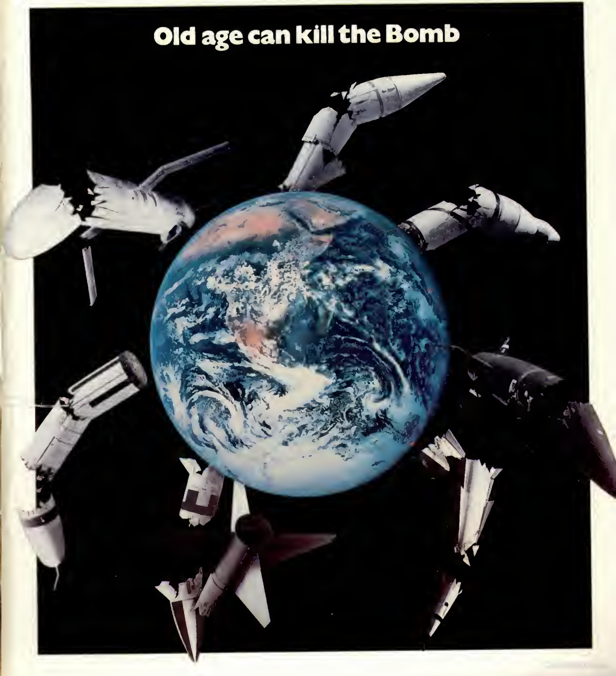
newscientist

Old age can kill the Bomb



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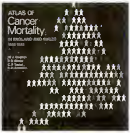

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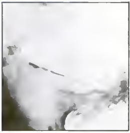

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A noble debate

ONLY OCCASIONALLY does the word science, except in its commercial incarnation, technology, echo around the corridors of power. It is, therfore, perfectly understandable that one of Britain's elder statesmen should discover science late in life. "I have learned more in one day than I have learned on a great many other days in my ministerial career." That was what Viscount Whitelaw said when he wound up a four-hour debate on a report from the Advisory Council for Applied Research and Development and the Advisory Board for the Research Councils (see p 5).

Now, Viscount Whitelaw is, and has been for some time, a leading member of the Conservative government. He is, despite banana skins, one of its survivors. On the other hand, he has never prevailed over a ministry responsible for science, so why should anyone expect him to be familiar with the arcane world of science? At least he had the grace to suggest that "as I started by knowing nothing, perhaps it is only an example of what I should have known before".

Such is the nature of debates on politics and science, that one question always crops up; one that would, if answered in the right way, make it harder for politicians as eminent as Viscount Whitelaw to see the light so late in life. Why isn't there a minister responsible for science? Or someone who has this task as a part of a wider portfolio?

On Friday, Lord Shackleton raised once again the issue of a political watchdog for science—as opposed to the able administrative watchdog, the Chief Scientist in the Cabinet Office. Commenting on a report from the House of Lords Select Committee on Science and Technology, Shackleton said: "interested though the Prime Minister is... it is not really practicable for the Prime Minister to fulfil the role that we sought". But the committee was not "seeking even something as modest as the Minister for Science... We are wanting somebody, for reasons we set out very clearly, to be concerned." "Some existing member of the Cabinet," he went on, "should have the responsibility of thinking about science and technology and should be recognised as such. It is something less than coordination. It is, in fact, somebody in Cabinet who would have the advantage of the Chief Scientist and who would have somebody to go to." Who better to do the job, said Shackleton, than the Noble Viscount himself?

Viscount Whitelaw agreed that it would be too much to expect the Prime Minister, whose life is a busy one, to do everything even though "my right honourable friend the Prime Minister is exceptionally jealous of her knowledge in science and of her position in dealing with these problems in the country as a whole." The noble Lords could not, though, persuade Viscount Whitelaw to take on another job—"recently I seem to have been attracting jobs, though not always, apparently, carrying them out very successfully. Therefore, I doubt whether I should take on any more." But the worthy Viscount was convinced of the importance of science and technology, and promised to report back to Mrs Thatcher.

In the past, it has sometimes seemed that it would be sensible to have someone who carried the science portfolio around the corridors of power. But governments change, as does the community of science. As thge debate showed plenty of important messages are not getting through to the government. So Lord Shackleton is right to seek something more substantial than the current system of chief scientists. However, it will take more than that to change attitudes throughout Whitehall and Westminster. □

An invitation to détente

THERE IS is still no word from the Soviet Union, as we go to press, of the fate of Yuri Orlov, the physicist condemned to seven years in a labour camp because of his campaigning for human rights. His imprisonment was due to end last Friday, and he may now be sent to "internal exile" somewhere in the Soviet Union, unless the Soviet authorities find some reason to send him back to prison.

Orlov's interest and expertise in physics lie in the area of high-energy particle-physics, the study of the basic constituents of matter. Many physicists at CERN, Europe's international centre for particle physics, have campaigned hard for Orlov's release, particularly through the Yuri Orlov Committee. Now the committee has made a direct approach to the governments of all CERN's member states. The committee would like CERN to offer Orlov a job, on the new accelerator project, a huge electron-positron collider, known as LEP. This would on the one hand allow Orlov back to the frontiers of his science, and on the other contribute to Soviet involvement in LEP, a world-beating machine. So far the committee has received favourable replies from around half CERN's member states and the Swedish prime minister in particular strongly supports the suggestion.

It would be nice to think that the UK's position was equally positive, although this country's track record as regards Orlov has been variable. Now however, the time seems particularly appropriate for the Soviet Union to show some willingness to improve relations with scientists in the West. For the Soviets to allow Orlov to work at CERN would be an important sign of such good will. CERNs should take the step of providing this opportunity.

Meanwhile, John MacDonald, Orlov's British lawyer, has suggested to the physicists at CERN that they should try hard to visit Orlov if indeed he is released to internal exile. This too would test the USSR's intentions, and would give Orlov the chance to find out what has happened in the past seven years, which have proved to be extremely exciting ones for particle physics. □

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Britain takes lead on chemical weapons

Time to stop gassing and lift the mask

The Times

THE BRITISH government has this week taken the initiative in the West's delicate negotiations with the Soviet Union over a complete ban on the manufacture, storage and use of chemical weapons. A minister of state at the Foreign Office, Richard Luce, presented a paper at the Conference on Disarmament now taking place in Geneva. The paper discussed the vexed question of how to ensure that any ban is adhered to. A key feature of verification, he said, should be the right of countries to challenge each other over whether particular factories might be making or storing chemical weapons.

The proposals would complement what the Foreign Office sees as the routine verification procedures that would ensure that countries conform to a chemical weapons convention. They would, for example, have enabled the United States to have sent in independent inspectors to see whether the Soviet Union had sprayed deadly mycotoxins, known as yellow rain, in Southeast Asia and Afghanistan. Both British and American governments believe this to be the case, but many scientists disagree.

At the centre of the new British proposals, which have been in preparation for more than six months, is the "challenge element". It is, according to the Foreign Office, a means whereby one country could challenge another if it suspected that it was not complying with the convention. It would do so through an international body that would be set up to police a convention. Any country that refused such an inspection following a challenge should, says the Foreign Office, be in breach of the convention.

Luce explained this week that if a convention is to convince international opinion of its effectiveness, then measures need to be taken that are additional to the routine inspections that verify that a country is not storing or making weapons or building a factory to make chemical weapons. Luce said that, without such a challenge procedure, there would be no means of settling doubtful cases, which could destroy confidence in the convention.

However, there is a feeling among some countries participating in the talks that there is a need to agree on a draft treaty, and wait until a later stage to hammer out the finer details. Alastair Hay, a lecturer in chemical pathology at the University of Leeds, and an expert on chemical warfare, said: "This could be easier than holding back until every last minor point is agreed." "At the moment," he said, "significant advances have been made despite the recent tensions that have developed between East and West over arms control."

The Soviet Union agreed in principle to on-site inspection of its facilities in 1979. This was reaffirmed in 1982 by the Soviet foreign minister, Andrei Gromyko, in what was seen as a breakthrough in negotiations. Since then, Britain, which destroyed its chemical weapons in the late 1950s, and the US, which stopped making them at the end of the 60s, have claimed that the Soviet Union has vast stores and production facilities geared up for chemical weapons.

President Reagan, in his budget speech two weeks ago, said that he wants to redress the balance by making a new generation of chemical weapons—the binary munitions.

These chemical bombs carry two canisters that contain non-toxic chemicals when kept separate. When mixed, during the flight of the shell, they form a deadly compound. The ease with which these can be made and stored and the difficulty of verification add a new dimension to the chemical weapons race. If no progress is made at the Geneva negotiations, Reagan said, then the US will begin building these binary devices by the end of next year. In his budget speach he announced that he wanted to spend $170 million in developing chemical weapons in the coming year. Estimates of Soviet stockpiles of chemical weapons vary from 30 000 tonnes, based on West German intelligence, to 700 000 tonnes. The US, meanwhile, has 42 000 tonnes, 40 per cent of which is ready to use in the event of war in Europe. The rest is stored in the US. ☐

OBSERVER David Austin
UNLIKE CHAIRMAN MAO, THIS LOT WILL LAST FOR A THOUSAND YEARS
EURO-WASTE
DANGER RADIO-ACTIVE

Chinese laundry opens for Europe's nuclear waste

CHINA has signed a letter of intent with West Germany to accept spent nuclear fuel from the the whole of western Europe for disposal in the Gobi desert.

If the letter ever becomes a contract, the three West German companies, Nukem, Transnuklear and Hempel, will act as agents on behalf of other European nuclear companies, collecting and transporting radioactive spent nuclear-fuel to China for final disposal.

Transnuklear, a subsidiary of Nukem, shares with British Nuclear Fuels (BNFL) ownership of Nuclear Transport Limited (NTL), which offers international spent fuel transport services. The Germans feel that NTL might transport radioactive fuel to China. However BNFL denied that either it or NTL have been consulted and neither company was aware of any details of the deal.

Any Chinese takeaway of Europe's waste would present international problems. The plutonium in the spent fuel would be checked by Euratom and the International Atomic Energy Agency (IAEA).

China joined the IAEA in January this year and, although it has accepted the principle of IAEA inspections, it has not signed the Nuclear Non-Proliferation Treaty. Since West Germany, in common with most other European countries, is a signatory of the treaty, shipment to a non-signatory of spent fuel would present problems.

Nukem said that it was discussing with the West German government the issues that would be involved in such shipments, and gave an assurance that spent fuel would go to China only when all the proper government consents had been given.

At this early stage, no details were available of the type of plant that the Chinese would build to accommodate the fuel. Nukem was, however, certain that such a deal would not jeopardise the integrated waste treatment plant that the German utilities hope to build at a disused salt mine on the border with East Germany. ☐

Prosecution for Sellafield leak is likely

BRITISH Nuclear Fuels (BNFL), the company that contaminated beaches near its nuclear reprocessing plant at Sellafield, Cumbria, now seems almost certain to be prosecuted. The first report on last November's accident, from the Health and Safety Executive (HSE), says that "breaches of relevant statutory provisions may have occurred".

A prosecution by the HSE would usually follow such a finding—but this time the government has got there first. The Department of the Environment (DoE), which also reported on the incident this week, has already asked the Director of Public Prosecutions to consider whether BNFL should become the first firm to be prosecuted under the Radioactive Substances Act of 1960.

Source of the leak: Sellafield's high-activity storage plant

BNFL

The HSE is particularly scathing about BNFL's method of keeping records and it recommends an immediate review. It was the failure of one shift manager to read the record made by another that lead to highly radioactive solvent and "crud" (sticky deposits) being accidently pumped into a tank where low level waste is stored before discharge into the sea.

The report also expresses alarm at the number of times—four in all—that the two sea tanks had to be emptied to flush out the radioactive material sticking in the sea pipes.

Concrete shielding protected many of the Sellafield workers during the incident, but a group of radiographers working near exposed pipes suffered radiation levels of some hundreds of millirems per hour, the report says. However, alarm bells had sounded and they left the area before receiving dangerously high doses.

The HSE's Nuclear Installations Inspectorate, which prepared the report, questions BNFL's calculation of how much radioactivity was actually discharged into the sea. About 4500 curies ended up in one of the two sea tanks as a result of the manager's oversight. BNFL estimates that not much more than 600 curies were eventually lost into the sea. The HSE, however, says the figure is hard to estimate, but that a "significant fraction" of the total radioactivity in the sea tank could have ended up being discharged.

The DoE, whose job it is to monitor discharges into the environment, published its own report on the incident this week. This and the HSE's own report will be passed to the Director of Public Prosecutions, along with the evidence compiled by the Cumbria police.

There are three laws under which BNFL could be prosecuted: the Nuclear Installations Act and Health and Safety at Work Act, which are the responsibility of the HSE, and the Radioactive Substances Act, which covers discharges into the environment and which the DoE and Ministry of Agriculture, Fisheries and Food police. The HSE considered prosecuting BNFL in the late 1970s following leaks into the ground from cracked waste tanks. □

Archaeologists accelerate back in time

PARTICLE physics has successfully come to the aid of archaeologists. The first dates for materials analysed at the new Radiocarbon Accelerator Laboratory in Oxford are published this week. One result has dated plant remains found in a 20 000-year-old Egyptian site at Wadi Kubbaniya at only a century or two old, thus confounding speculation that the domestication of plants in Egypt may have been under way thousands of years earlier than currently supposed.

The Oxford laboratory's first results have been eagerly awaited (*New Scientist*, 21 July 1983, p 181). The laboratory is a great advance on previous generations of machines that use carbon-14 dating techniques. The Oxford accelerator is much faster and requires only one-hundreth as much material to work from.

Carbon-14 is present in known qualities in living matter but, after the material dies, it slowly decays to other isotopes. Past machines have measured the slow natural decay of carbon-14, which has a half-life of 6000 years. But the new machine counts the carbon-14 atoms themselves, rather than the decay products.

Most of the 17 dates in the first published list from the laboratory have been arrived at from tiny quantities of material, often little more than a milligram. A small ivory gouge from an early South American site has been dated to 14 000 BC, and minute samples prove that inlay in a pair of Islamic doors is the original wood.

The accelerator also dated the carbon-black left by a smoky fire on the outside of a cooking pot—something which past machines could not have done.

The machine may soon share in a dating that will catch the headlines—the analysis of cloth from the Turin shroud, which is expected to begin soon. □

New blood scheme is bad for women

WISE'84
WOMEN
INTO SCIENCE &
ENGINEERING

BRITAIN'S "new blood" scheme for university lectureships has come under scrutiny from the president of the Women's Engineering Society, Professor Daphne Jackson, because it discriminates against women candidates. She proposes an extension of the scheme, designed specifically for women who return to work after having children.

New blood appointments, introduced in 1983, are open only to applicants aged between 27 and 35. Women of this age are often busy raising families and Jackson, who is Dean of the Faculty of Sciences at the University of Surrey, found that when she advertised two physics jobs with similar age restrictions last year, she received no applications from women. "I am now convinced," she says, "that age discrimination is sex discrimination."

The University Grants Committee (UGC) recently told vice-chancellors that only 8 per cent of the new blood posts offered in 1983 went to women. Jackson, however, does not believe the scheme should be scrapped, since in other respects it has been a great success. Nor does she think increasing the upper age limit for women would solve the problem.

Instead, she has written to the chairman of the UGC, Sir Peter Swinnerton-Dyer, proposing a new scheme by which women wishing to return to academic work or research in industry could apply for 3-year part-time fellowships. The fellowships could be made permanent if the women proved good at the job.

"The presence of a woman academic contributes greatly to recruitment of women students," Jackson says. She suggests that the fellowships should be open to women with a good honours degree and several years' professional experience in physical sciences or engineering. They should be between 25 and 47 years old but preferably over 30. Jackson would like to see about 15 fellowships offered in the first year, but thinks double that number would be necessary to make "a significant impact".

The scheme might be eligible for a grant from the European Social Fund. The fund has already allocated money for the retraining of women, and could cover half a trainee's salary as well as half of the university's overheads and, perhaps, costs of child-care as well.

Swinnerton-Dyer has yet to comment in detail on Jackson's proposal. □

Lords clash over science policy

Press Portrait Service

Whitelaw: learned

RTZ

Shackleton: cuts

THE British government will not be drawing up a national strategy for industry, or even for industrial R&D. Nor is it likely to provide any extra funds for applied research, according to its spokesman, Lord Lucas of Chilworth, in the House of Lords last Friday.

In a marathon 4½ hour debate on science and technology, Lucas said that the government would instead encourage the development of new technologies through its role as a purchaser. And it would shift the emphasis of state education to subjects of "more direct relevance to industrial and commercial development", such as information technology.

The debate considered the first joint "state of the nation" report by the chairmen of the Advisory Board for the Research Councils and the Advisory Committee on Applied Research and Development (Cmnd 8957). Illustrious scientists among their Lordships used the occasion to voice their concern about the state of science and its effect on the nation's prosperity.

Lord Shackleton, erstwhile explorer, director of Rio Tinto Zinc and member of the House of Lords' select committee on science and technology, represented a popular view when he said that "it is no use saying that the science vote has been protected, because it has not". Physician and researcher Lord Richardson, echoed this view, so did the Earl of Selbourne, chairman of the Agriculture and Food Research Council (AFRC), who said: "We know that basic research has already lost out because of crippling cuts in basic funding from the University Grants Committee."

Several of the science lords also agreed about the need for selectivity in research—first in choosing the right industries to back, and then in fostering centres of excellence in various disciplines. Lord Gregson, a nuclear researcher turned company director, said that "selection is essential", and selection without a strategy would be "the logic of Alice in Wonderland".

Other lords said that the government should help to develop such strategies. The Earl of Selbourne said "we have to face the fact that research is getting more expensive, that funds are finite.

He went on to point out that, in drawing up and implementing such a strategy for research, the government should think on longer time scales. "There must be a degree of commitment to strategic research", he said. A decade was the correct kind of timescale. He complained about receiving just three months' notice of the government's intentions commissioning research from AFRC. "There is simply no way you can run a coherent research programme with that degree of expediency" he said.

Winding up, Viscount Whitelaw said "I have learned more in one day than I have learned on a great many other days in my ministerial career." ☐

Watchdog should open its eyes

THE HEALTH & SAFETY Executive (HSE) should gather information to find out whether working in a particular place can be linked to disease, and it should spend some of its research budget on follow-up work where necessary.

This recommendation is one of several to emerge from a House of Lords select committee report published on Monday. The committee's brief was to "consider the future provision of occupational health and hygiene services."

If the HSE were to act as a clearing house for information from industry, trade unions and doctors about an employees illness it could identify whether certain jobs or environments cause disease, says the report. Such an approach might have worked with the hazards of asbestos.

The committee also concludes that millions of workers in small or medium-sized companies in Britain have little or no provision of occupational health or hygiene services. To counteract this the HSE should publish a code of practice. The committee disagrees with the Confederation of British Industry, which says that small firms need no special attention unless a specific problem is identified. "It is in small firms that risks are less likely to be detected or acknowledged".

The committee says employers should bear the cost of maintaining an occupational health service, but does not recommend a statutory code because this could affect "international competitiveness". ☐

Popperfoto

Unseen hazards

Select Committee on Science and Technology—Occupational Health and Hygiene Services. HMSO, £4·65

Biotech centres cloned

THE FIRST international centre for biotechnology in the Third World has found a home—or, rather, two homes. After months of wrangling, the International Centre for Genetic Engineering and Biotechnology, sponsored by the United Nations Industrial Development Organisation, is to be established at two centres—in India and Italy. The decision puts an end to a tug-of-war between at least six countries who wanted to host the centre. But it will double the cost and leave the centre short of money.

Italy has pledged 60 billion lire ($38 million) to establish one centre near Trieste. It will specialise in industrial microbiology and new energy sources. India, meanwhile, is to give $19 million to set up a facility in New Delhi which will research human and animal health and agriculture problems. The United States, Britain, France and Japan have all refused to help pay for the scheme, which is still $17 million short of its target. ☐

Asbestos risks

AIRBORNE asbestos fibres, floating in the atmosphere well away from factories and other "hotspots", may cause cancer—though probably not very often. So concludes a study by the National Research Council in the US. Children may be at special risk, the council says, because their lungs may be especially sensitive to fibres. The risk of mesothelioma—a rare cancer of the lining of the lung—from exposure to asbesto fibres is "markedly increased" among young children, says the study. ☐

Barclay ban lifted

BELGIAN consumers have won court backing for their claim that advertising for Barclay, the "99 per cent tar-free cigarette", is misleading. The case arose when British-American Tobacco (BAT), which makes Barclay, obtained a pre-publication copy of the February edition of the Belgian Consumer Council's magazine. The magazine called BAT's advertising "false and deceitful" and quoted the US Federal Trade Commission, which says that Barclay delivers up to seven times the amount of tar claimed (*New Scientist*, 14 July, 1983, p 85).

BAT sought an injunction to forbid distribution and the court initially backed the firm. But last week the court reversed its decision. It ruled that freedom of expression must take precedence over the protection of commercial interest. Last year, the Amsterdam courts refused to prohibit BAT from advertising Barclay since its tar delivery had been tested by a legally approved method. Since that judgement, BAT Nederland has launched a new advertising campaign with greater emphasis on its low-tar claim. ☐

Called to account

THE OWNERS of dangerous chemicals may soon have to pay for the damage caused when their products are lost in spills at sea. The International Maritime Organisation, an agency of the United Nations based in London, will propose a convention on liability for chemical disasters at sea, at a conference in May.

The organisation is preparing a short list of chemicals that are carried in bulk by sea and which could be covered by the convention. They include chlorine, phosphorus, liquefied natural and petroleum gases, creosote and acetone. But more esoteric materials, such as the weedkiller Dinoseb, which spilt from a Danish ship onto the Dogger Bank in the North Sea last month, will not be covered. ☐

Traffic lights could save Severn Bridge

Mick Hamer

Safe, 99·9 per cent of the time

Popperfoto

A SET of traffic lights at either end of the Severn Bridge could save the government more than £20 million.

Last week, Nicholas Ridley, the Secretary of State for Transport, announced a £33 million plan to maintain and strengthen the bridge to enable it to meet new safety standards. Yet this strengthening is unnecessary, according to some engineers.

Freeman Fox and Partners, the firm which designed the bridge, says that the original design-load for the 990-metre central span of the bridge was 2000 tonnes. Even with today's heavier lorries, the weight of traffic on the bridge does not exceed 300 tonnes for 98 per cent of the time. The load only very rarely exceeds 1200 tonnes. Yet the strengthening, which will cost more than £20 million, is designed to enable the bridge to meet a new design-standard of 5000 tonnes on the main span.

Instead of spending such huge sums on strengthening the bridge, ministers could allocate a few hundred thousand pounds on a traffic-control scheme.

The problem with the Severn Bridge is the number of heavy lorries that use it. According to Mott, Hay and Anderson, one of the firms of consultants which examined the bridge recently for the Department of Transport, the bridge could collapse if it sustained a load along a 200-metre section of the main span of 700 tonnes, the weight of 18 38-tonne lorries.

But such a load would occur extremely rarely and could easily be controlled by traffic signals, according to Freeman Fox and Partners and other engineers. A small computer linked to the traffic signals, together with a vehicle detector such as a video camera or axle-weight sensors, could meter the flow of heavy lorries and break up convoys so as to avoid a juggernaut jam. The traffic signals would control only heavy lorries, because cars do not have a significant effect on bridge loadings.

Alternatively, the toll booths, which are presently all on the English side of the bridge, could be moved to the Welsh side for eastbound traffic. The booths could then control the number of heavy lorries allowed on the bridge at any one time.

A senior engineer at the Department of Transport says that the department had maintained strict secrecy over this scheme.

A traffic-control scheme would cause slight delays to heavy vehicle drivers on only a few occasions. The government's strengthening programme will cause considerable disruption to traffic and take up to six years to complete.

Between 1970 and 1982 the number of lorries with more than three axles using the Severn Bridge rose by 250 per cent. And the maximum lorry-weight increased from 24 tonnes in 1966, when the bridge was opened, to 38 tonnes today. These increases have caused the bridge to age prematurely. To meet this increase in heavy lorries, the loading standard for bridges has been raised from 6 kilonewtons per lane per metre to 18 kilonewtons per lane per metre.

The cables of the Severn Bridge are strong enough to meet this new standard. But the rest of the bridge's structures will have to be strengthened. At least £100 000 will be spent on strengthening the anchorages of the main cables. £1.2 million will go on stengthening the twin towers, possibly by inserting new struts, along with £4 million on rewelding the steel deck of the bridge and £2.3 million on replacing the hangers, which suspend the road deck from the cables.

The Severn Bridge has a novel system of inclined hangers, instead of the vertical hangers on conventional suspension bridges. The debate about whether the inclined hangers, which are said to damp the bridge aerodynamically, will be replaced by vertical hangers is unresolved. It will be the subject of further studies. Some £9 million in the total budget is set aside for design, supervision of work and "uncertainties". □

High winds on the Tyne

HIGH winds have only forced the closure of the Severn Bridge once since it opened in 1966. However, the Redheugh Bridge over the Tyne Valley has already been closed twice this year and high-sided vehicles have been turned away on 14 days. The cause is the strong westerly winds which whistle down the Tyne Valley.

The Redheugh Bridge replaced an earlier bridge across the Tyne, which will soon be demolished. But the new bridge, opened by the Princess of Wales last year, is closed to all traffic when the wind exceeds 80 km per hour. And it is closed to high-sided vehicles when the wind exceeds 64 km per hr. Because the bridge is high up on the valley sides and exposed to the full force of the wind, such occasions have proved unexpectedly frequent.

Nine bus routes cross the bridge, and five of them are operated by double-deckers. On average a bus crosses the bridge every five minutes. The bus companies are so worried that they have commissioned wind-tunnel tests at the Cranfield Institute of Technology. The initial test results are worrying enough for the bus operators to step up the research programme. □

Brussels' din drowns plan for noise

A ROW in Europe is holding up new laws that could protect the hearing of 16 million workers. The dispute centres on the amount of noise that people should be exposed to at work.

For the past two years, the European Commission has been trying to draw up a directive that would cut levels of noise to 85 dB (A) over eight hours. This is slightly more noisy than heavy traffic, but less noisy than most factories. The commission estimates that between 10 million and 16 million people in the EEC work in noisier surroundings.

Employers have long opposed the limit of 85 dB (A) because of its cost. The Confederation of British Industry, which represents employers, estimates that following the European code would cost British firms more than £1 billion. Employers would prefer to stick with the existing limit of 90 dB (A).

Now the European parliament's environment and health committee has also backed the 90 dB (A) standard. It has published a report on noise which points out that, since the decibel scale is logarithmic, 85 dB (A) has only one third the noise energy of 90 dB (A) and the higher figure doubles or triples the risk of damage to hearing.

But the committee proposes that employees should wear ear protectors when noise levels exceed 85 dB (A). This would be far cheaper than making less noisy equipment. Ear protectors cost around £17 per worker every year, while adopting the directive's lower limit would cost nearly £6000 per worker, the committee said. "There is no cost-benefit information in the commission's text," says John Biesmans, public health adviser to the European Democrat group in parliament.

In Britain, factories that expose workers to noise of greater than 90 dB (A) risk prosecution under the Health and Safety at Work Act. But there is no specific law on noise; the Health and Safety Executive has been waiting for a decision to emerge from Europe. □

Gene cloning 'could further biological warfare'

Genes at work

Christopher Joyce, Washington DC

AMERICA'S guardians of genetic engineering, the Recombinant-DNA Advisory Committee (RAC), last week approved the cloning of a gene for a potent toxin, despite protests from activists opposed to genetic engineering. This decision is the latest skirmish in the battle to establish who should regulate such experiments.

The toxin is found in a strain of *E. coli* and has the same properties as that produced by *Shigella dysenteriae*, the bacillus responsible for a type of dysentery that causes many child deaths in the Third World.

Objections to the proposal were raised by Jeremy Rifkin, an author and activist, who says the experiment could lead the world toward biological warfare. Two microbiologists at the Uniformed Services' University of the Health Sciences, part of the medical corps of the US Department of Defense, are behind the experiment. This unit is separate from that part of the military authorities involved in chemical and biological warfare. The researchers say that they are pursuing only questions of basic microbiology and perhaps, eventually, a vaccine. Such a vaccine could be made from *E. coli* once the gene coding for the Shiga-like toxin has been isolated and removed.

At the RAC's meeting in Bethesda, Maryland, on 6 February, Rifkin insisted that the government should prove that it has no intention of developing a biological weapon before the experiment proceeds. The RAC, an 18-member panel consisting mostly of academics in biomedical disciplines, nonetheless gave its approval.

Supporters on the RAC said that the gene for Shiga-like toxin is not dangerous by itself, and that it appears in nature in several types of bacteria. But the vote was split nine to five in favour of the experiment, with four abstentions, and Rifkin may yet get his way. The final decision is up to the National Institutes of Health (NIH), which oversees the RAC's work. In the past the NIH has often rejected proposals approved by the RAC in split votes.

At the meeting, the RAC also faced tough questioning of its qualifications to judge the environmental effects of releasing new organisms into the environment. Rifkin, backed by several scientists, argued that the RAC has no ecologists aboard to judge proposals for releasing microorganisms of plants outside the laboratory. He has begun legal action to force the government to perform an environmental review for every such proposal.

Confusion reigns over who, other than the RAC, should handle environmental reviews. Those in Congress who are most interested in biotechnology said last week that the RAC is not equipped to judge experiments outside laboratories. They say it should hand the job over to a special panel of government experts. Some people in government suggest that environmental and agricultural agencies should have the job, yet officials from these agencies say they are not ready yet.

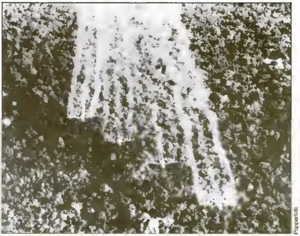
Other critics do not want the RAC to continue hearing proposals from private industry in secret, a practice that also bothers some of the RAC's members. Yet industry insists on secrecy. So perplexed is the committee that it improperly notified the public of the closed portion of last week's session, when it was to hear a biotechnology company's proposal to test a mutant strain of *Pseudomonas syringae* in a vegetable patch. But a federal court then forbade the review on a technicality, and the proposal, from Advanced Genetic Sciences of California, has been put off until June—well past this year's planting season, according to officials at the NIH.

Companies are not compelled to seek the RAC's approval for experiments, but have done so voluntarily to date. To date, three outdoor tests involving genetic clones have been approved. Yet no one wants to go ahead with their experiments for fear of being sued—until Rifkin's action against the NIH is settled. □

Vietnam veterans tell their herbicide horror stories

AN AUSTRALIAN Royal Commission is holding public hearings into the use and effects on its servicemen of chemicals sprayed on Vietnam during the war there in the 1960s and early 1970s. A mass of anecdotal evidence from participants suggests that the indiscriminate spraying of herbicides, such as Agent Orange, frequently drenched Australian and American troops as well as the Vietnamese. Many ex-servicemen believe that they are still suffering the after effects.

Stanford Freeman, a former army signals operator, told the commission that the Australian base at Nui Dat was accidentally sprayed with herbicide in 1966. An American air force plane made two runs over the camp before realising its mistake.


Popperfoto

Spraying a mangrove forest near Saigon; anybody down there?

Another ex-serviceman, Robert Gibson, took part in experiments in spraying herbicides in late 1967. Now he claims he suffers from dizzy spells, burning sores on the back of his neck and tingling in his feet.

Gibson says he and his colleagues were issued with rubber gloves, goggles and a mask. But they were allowed to take off the masks because they could not breathe. Hoses constantly sprayed on the men and the herbicide ran down their arms, drenching their clothing. Immediate effects had included severe irritation of the eyes, headaches and a runny nose. Today Gibson suffers extensive bleeding from his bowels, anxiety, moodiness, insomnia and numbness and tingling in his feet.

Other witnesses claim they were in the flight path of American planes on spraying missions. One official from the Federal Department of Veterans Affairs, Bruce Manning, told the commission that any man serving in Vietnam would have been exposed to chemicals within one month of being in the country.

John Bamford, a land-management officer with the Victorian government claimed that, while spraying blackberries in 1970, he was locked naked in a tank of 2,4,5-T by his workmates.

He explained that, if the agitator in the spray tank was not working, one of the junior members of the team stripped off and got inside the tank, which was usually full of herbicide, and tightened the fittings of the agitator. On this occasion the tank contained around 600 litres of herbicide. It was five hours before Bamford reached home and washed the herbicide off.

The present hearings are concentrating on the extent of the exposure of Australian troops to chemicals. Further hearings in March will deal with the psychiatric, physical and genetic effects of the herbicides.

In conjunction with the Royal Commission's hearings, a health study of 5000 servicemen, 3000 of whom served in Vietnam, begins this month. □

Farmers win last-ditch stand in Whitehall

Catherine Caufield

THE WIDENING gap between government policies on agriculture and the environment are being explored by two committees of the House of Lords. One interesting area they may explore is why ministers took more than four years, until December 1983, to reply to the Royal Commission on the Environment's report on agriculture and pollution.

Senior sources in Whitehall say that a positive response to the report, including support for a number of reforms, was prepared by civil servants in 1981. But it was vetoed by senior mandarins at the Ministry of Agriculture, Fisheries and Food (MAFF), with the apparent support of MAFF's secretary of state, Peter Walker. A more toothless response, which broadly supports the status quo, was then prepared. The debacle is bound to increase concern about the power of ministers who also own farms to influence countryside policy.

The response to the Royal Commission was a joint effort by MAFF and the Department of the Environment (DoE). It was announced to the House of Commons by the environment secretary, Patrick Jenkin. He claimed: "We have been able to accept most of the recommendations." But many members of the commission, which was chaired by Sir Hans Kornberg, are angry. They believe that ministers have turned down or sidestepped most of the reforms that they proposed. Controls proposed for pesticides suffered especially.

Martin Mayer

Forestry Commission

Keep spraying: Walker (top left) sanctioned the spiking of reforms. Jenkin made the announcement

One of the commission's main recommendations was that the voluntary Pesticides Safety Precautions Scheme—under which manufacturers, distributors and importers agree to sell only approved chemicals—should have legal backing. The British Agrochemicals Association (BAA) also wants the scheme given statutory support in order to avoid a conflict with the EEC, which regards such voluntary agreements as infringements of free trade.

The government, however, has rejected the recommendation. Apparently ministers fear that parliamentary scrutiny would result in demands by MPs for more radical changes, such as the publication of toxicity data and more stringent monitoring of the effects of pesticides.

The commission also recommended that data on the toxicity of pesticides should be available more freely. Ministers turned this down, arguing that "a guarantee of confidentiality is essential to the success of the pesticides control arrangements". Oddly, this hard line was immediately undercut by the BAA, which now wants the government to set up a system for making such information available.

The quantity of pesticides produced and used in Britain is still a secret. But the government is now "considering" accepting the commission's advice that such information should be public. It has rejected the idea that a scheme similar to the yellow-card system, used by doctors to keep track of possible side effects of drugs, could improve monitoring of the effects of new pesticides.

Ministers also reject the idea that the Food and Drugs Act of 1955 should be amended so that it no longer encourages the overuse of pesticides by requiring food processors to produce "absolutely pest-free products". As one commission member put it, consumers should be less worried about the caterpillar they can see than about the pesticides they cannot. The government argues, however, that the decision on how much pesticide to use is "essentially a matter for producers' commercial judgement".

People living in an area where pesticides are sprayed by aircraft should be given advanced warning, said the commission. Sources in Whitehall say that civil servants wanted this proposal to be accepted. But ministers who themselves farm objected. So the government will only say that it is "still considering the matter". It has, however, flatly rejected the commission's idea that there should always be somebody on the ground, during spraying from aircraft, who could give locals the name of the operator and the substance being sprayed.

The government agreed to fund more research into ways of improving the efficiency of the application of pesticides and of minimising the spread of resistance to pesticides. Yet ministers have forced cutbacks in research into pesticides by the Agriculture and Food Research Council. And later this year, a programme at the Cambridge Plant Breeding Institute to develop aphid-resistant varieties of wheat will end.

Other proposals rejected by ministers include requiring factory farms to submit to planning controls and supervision of smells and wastes in the same way as industrial factories and new guidelines for how much fertiliser to spread onto land.

As one close observer concluded, civil servants often will not push for reform because "they know that if it gets to cabinet there will be 15 farmers sitting round the table". □

Defeated video-pirates look forward to cable

CABLE TV could revitalise the video pirates in Britain, warns Peter Duffy, formerly commander of the anti-terrorist branch at New Scotland Yard. Duffy now fights the video pirates for the Federation Against Copyright Theft (FACT), which was created a year ago and is financed by legitimate video and film companies.

Although the £1 million spent by the federation in its first year bought the seizure of only £1 million worth of illegal cassettes, the pirates are in trouble. Under the new, tough laws introduced in July, they face jail terms and unlimited fines. A year ago, 6 out of every 10 videocassettes sold or hired in Britain were pirate copies—often mass-produced. Now only 4 out of 10 is illegal. Usually they are home-made in small numbers and distributed through mobile "libraries".

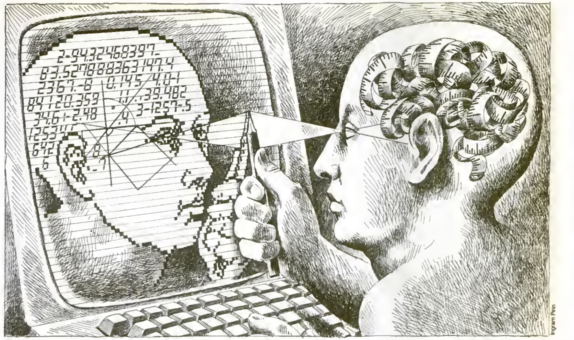
FACT believes it has temporarily turned off the tap for the source of the professional criminals' most lucrative material—new feature films offered on pirate video before their legal release. Sixteen people are currently awaiting trial for stealing films from cinemas to produce pirate videos.

This time last year, thousands of people had seen high-quality pirate versions of *ET* before its release. Now the only first-run films on video offer very poor quality pictures because they have been copied several times from American originals.

Duffy says he is "very concerned" about Britain's plans for cable TV. When the cable companies, which were recently licensed by the government, start piping new films into people's homes they will effectively be handing out high quality master material almost free to the pirates.

One solution would be for the government to forbid cable companies to transmit films before they are available on video. But this would be a commercial handicap for the cable companies, who will be trying to sell subscriptions on the back of new films available only on cable.

A more viable alternative is already in use in some German hotel cable-systems. At a crucial point of the film, a copyright warning notice is superimposed on the picture so that the source of illegal copies can be automatically identified. □



Ingram Pinn

Digital computers can now mimic many of the skills of the human brain. But do they 'think' as we do, or we like them? Professor John Maynard Smith, as engineer turned biologist, suggests that whatever the brain does in solving problems, it is very different from the cogitations of machines. On page 11, however, Professor Margaret Boden, a cognitive psychologist, suggests that the resemblance is greater than it seems

Matchsticks, brains and curtain rings

A digital computer relies on fancy mathematics to find the distance from A to B. But the brain probably does the equivalent of counting matchsticks laid out on a map

John Maynard Smith

THE HISTORY of biology suggests that we understand how animals do something only when we invent machines that do the same thing. Animal flight was a mystery until engineers understood the aerofoil. To give a more controversial example, the nature of heredity and the genetic code was understood only after the invention of gramophones, tape recorders and other information-processing machines. It is therefore natural to hope that the invention of computers, which do many of the things that brains do, will help us to understand how we think. Is this hope justified?

The one great advantage of programming a computer to simulate a natural process is that you have to say exactly what you mean. If someone programs a computer so that, when shown a picture, it can correctly say "that is a pyramid standing on a cube", we can be sure that the process that has been programmed does actually work. That is important, because biology is full of verbal assertions that some mechanism will generate some result, when in fact it won't. However, can we be sure that the way the computer does it is in any way similar to the way you and I do it?

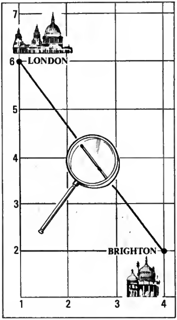
Some differences between brains and computers are unimportant. It need not matter that computers are made of transistors and brains of neurones, provided that the way they perform calculations are logically similar. This idea of similarity – more precisely, "isomorphism" – is so important that I will give an example. Cricket umpires are said to count the balls in an over by moving six pebbles from one pocket to another. It would be easy to give them an electric counter with six switches, arranged so that a bell rang when all the switches were on. If an umpire counted balls by moving a switch after each ball, he would be behaving isomorphically with a pebble-moving umpire. Notice, however, that if he simply said one, two, three and so on as a ball was bowled, this would not be isomorphic, because each sound is different from all the others, and it matters in what order they are made, whereas the pebbles can be all alike, and can be moved in any order.

A deeper difference between computers and brains is that the former are digital devices and the latter analog ones. Unfortunately, the word "analog" has two distinct meanings, one of which is usually forgotten. I first met an "analog computer" during the war, when I was working on aircraft design. It was important, early in the design, to estimate how the aircraft would vibrate. We did this by building an electric circuit which would behave in a way analogous to the aeroplane. This can be done because the behaviour of a tuning circuit (which in a radio can be altered to resonate in tune with particular radio waves) is exactly analogous to that of a weight on a spring (both obey the differential equation $d^2x/dt^2 = -kx$). The oscillations of the circuit then predicted how the structure would vibrate.

The old analog computer differed from a modern digital one in two ways. First, electric currents in the analog machine varied continuously, whereas in a digital one each transistor is in one of two states. Consequently, "analog" has come to mean "varying continuously". Now, I think a neurone is best thought of as an analog device. It is true that a nerve fibre either fires or it doesn't: in that sense it is digital. But the frequency of impulses in a fibre can vary continuously, from zero to some upper limit. However, I don't think this really matters. As anyone who has played Space Invaders knows, it is easy to get a digital device to behave in a nearly continuous manner. It is in fact possible to build out of transistors, or other all-or-none devices, units which behave very much like neurones.

There is, however, another meaning of the word "analog" which may matter more. The electrical analog of a mechanical system works because the laws of physics are as they are: if the tension in a spring increased as the square of its extension, the thing wouldn't work. In other words, an analog computer works by simulating one physical system by another one governed by the same mathematical equations. This can sometimes offer a simple way of solving a problem which otherwise would be very laborious. As an example, consider the following classic problem. You want to go by air from London to Moscow in the shortest possible time. You are given a list of 40 cities, including London and Moscow, together with the time taken to fly direct between any pair, given that a direct flight exists. Assuming that waiting time is zero, you must find the route for which the sum of the times is a minimum. On a digital computer, the problem is in one sense trivial. You search all possible routes, and choose the shortest. The only snag is that the number of possible routes is immense, so the calculation would take too long to do. There is probably a better way of doing it, by cutting down the number of possible routes that need to be measured: I don't know if one has been found.

The problem is easily solved, however, on a purpose-built analog computer. This device consists of 40 curtain rings, each representing a city. If there is a flight between two cities, the rings are connected by a string whose length in inches equals the flight time in minutes. To find the quickest route, take hold of the London and Moscow rings, and pull them apart: when a set of strings becomes taut, that is the best route.



Maths or matchsticks: two ways to estimate distance. Which does the brain use?

The point of this example is to show that a physical analog (time corresponds to length: times and lengths can be added by placing them end to end) can sometimes solve a problem in a way which is *not* isomorphic with the way one would program a computer to do it. Could this be true of brains? I think it may be. Consider, for example, the problem of judging distances. This may arise in at least two contexts. First, how do we judge the apparent distance between two points in our visual field? (I am not asking the harder question of how we judge real distances, allowing for foreshortening.) A topological representation of our visual field is present in the visual cortex of the brain, with particular points on the retina corresponding to points in the cortex. Hence the problem reduces to that of how one estimates the distance between two neurones in one's brain.

The second context is that of judging the distance between two places we have visited. It seems that humans, and some animals, do form "cognitive maps": that is, they have some representation in their heads which carries the same information that a map would convey. To digress for a moment, it is not easy to design experiments that will distinguish between an animal which finds its way from *A* to *B* by using such a map, and one that does so by following some learnt rule of thumb, such as "first left, second right". However, that would take me too far from the topic of this article, so I shall assume that at least some animals do form maps. It does not follow that the representation consists of a sheet of tissue in which particular neurones correspond to particular places, and in which the neurone map is topologically similar to the real one, but this seems much the most plausible assumption. If so, the problem of judging distances also reduces to measuring the distance between two neurones.

Before asking how the brain might measure such a distance, I want to describe two ways of measuring distance which are *not* isomorphic to one another. I give you a one inch to the mile map, and a box of matches, and ask you to find the distance from London to Brighton. One way would be to take map references of the two towns, say (60,10) and (20,40), and use Pythagoras's theorem (which relates the lengths of the sides of a right-angled triangle: $a^2+b^2=c^2$, where c is the longest side of the triangle) to find the distance: $[(60-20)^2 + (10-40)^2]^{\frac{1}{2}} = 50$ miles. This way is isomorphic to the way one would program a digital computer to do the job. Alternatively, you might notice that the matches are one inch long. If so, you would arrange them end to end in a straight line between the towns, and count the matches.

I think the latter method is more likely to be isomorphic with the way the brain makes such estimates. For example, the distance between neurones *A* to *B* might be measured by the time a message takes to go from *A* to *B* and back again. The alternative, of using Pythagoras, seems implausible. Indeed, I doubt whether our brains add or multiply in ways isomorphic to a computer. The latter uses a place notation, just as an abacus does, with different elements corresponding to units, tens, hundreds, etc (or, more usually, 2s, 4s, 8s, etc). I would be surprised if there is anything isomorphic to this in our brains.

If I am right about this, it casts some doubt on the belief that, by understanding how computers solve problems, we shall learn how brains do. However, it is unlikely that I am right. I have been doing something that I disapprove of strongly when it is indulged in by others: I have been pontificating in public about matters of which I am largely ignorant. My excuse is that I have extracted a promise from Margaret Boden, who does know something, to write a rejoinder. □

Professor John Maynard Smith FRS is the Dean of the School of Biological Sciences at the University of Sussex.

Ingram Pinn

Sorting out the tigers from the zebras

Brains do not have to solve spatial problems by manipulating geometric theorems—but then neither do computers

Margaret Boden

JOHN MAYNARD SMITH doubts that we shall learn how brains solve problems by studying how computers solve them. But which problems, and which computers? And how should we describe "how" brains or computers solve these problems?

As a biologist, Maynard Smith is interested in how we solve the sorts of problem which some other animals can solve too—such as estimating distance. He claims that whereas animals do *not* do this by invoking Pythagoras's theorem or the like, digital computers programmed to perform such tasks *do*. He ignores the question how human animals are able to understand Pythagoras's theorem as such, and so shall I. Let us concentrate on his example of the visual estimation of distance.

Maynard Smith regards analog devices as crucial. He admits that the "continuous-discrete" distinction between digital and analog computers is irrelevant, and that objections to digital computers based on this distinction are a red herring. But he makes two claims which, if true, would show digital computer-modelling of the brain to be a waste of time.

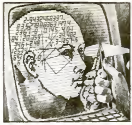
First, he says that only analog devices could help us understand psychological powers such as the estimation of distance. And secondly, he assumes that digital computers cannot function as analog devices (in which structural isomorphism is representationally significant). The second claim is simply false: a digital computer can use closeness in a visual array to represent physical closeness in the world. The first claim is more interesting—partly because (as in the hoverfly mentioned below) there are biological examples where it does indeed seem to be the case that an analog device is responsible for estimating distance.

Maynard Smith rests his case on the fact that analog devices behave in ways that are isomorphic with the system being modelled. This isomorphism, he says, pertains because of the laws of physics: electric circuits can model aircraft vibration, and string can model flying-time, because the relevant aspects of their behaviour are governed by the same mathematical equations. The model has merely to behave. If we interpret its behaviour as providing an answer to a certain question, that is our affair: it has nothing to do with the intrinsic nature of electric circuits, or string.

This type of example suggests not only that the problem-solution can be arrived at by the system's undergoing physical changes (which no materialist would deny), but also that to understand how it is reached it is sufficient to understand the device *qua* physical mechanism. But is this true, where the brain is concerned?

It might be, were the problem merely to compute the distance between two image-points (or, for that matter, between two points in a "cognitive map"). But brains have evolved under selective pressures which favour visual computations relating to things in the environment, not just to retinal images. And *interpreting* an image (or a map) in terms of real-world distance is, as Maynard Smith himself admits, a "harder" problem.

Suppose an animal's brain can register the fact that there are in the image several (broadly parallel) lines of discontinuity in light-intensity: in other words, that there



is a "stripey" image. So what? In the highly limited interest of enjoying a quiet life, such information could be useful. Since there is presumably *something* out there causing the image, even if this is a shadow and not an object as such, a species might evolve which uses stripey images to trigger withdrawal. (Though why it should discriminate and respond to stripey images, as opposed to spotted ones, is unclear: only if its main predator was striped would this make evolutionary sense.)

But what if a creature is to rely on its sight to know just what (among many possible things) that environmental "something" is, and where, and whether in this instance it should sit tight or run for its life? Then it needs a visual system capable of interpreting stripey—and non-stripey—images in terms of real things: tigers or zebras (and leopards), recognised as being large or small, near or far, moving or still.

The basic task of such a visual system is to map the two-dimensional image onto the three-dimensional world. That is, it must use the light-intensities available in the image to generate reliable conclusions about the environment. Since the image was formed by light from the environment in the first place, a plausible mapping from two to three dimensions must somehow exploit physical facts about image-formation.

But the "physical facts" concerned are not specific values of isolated parameters. Rather, they are general facts about the way in which images are formed, given the properties of light and physical surfaces. As the distorting mirrors in funfairs suggest, a given image might be caused by an indefinite variety of physical objects. So the visual system has to be constrained not only by the laws of optics, but by general truths about the environment.

Whatever the physical properties of a visual system may be, it must function in such a way that these general facts constrain the interpretations it makes. Its judgments of distance, for instance, can be made only if it allows for such matters as surface-texture, orientation, illumination, and stereopsis. What it does (its biological function of *seeing*) can be scientifically understood only in these terms.

That is, any visual mechanism capable of computing the distance between two physical objects, allowing for foreshortening in the process, must be understood as a computational device. The eyes may be made of protein, or silicon, or anything else that responds to light. And they don't have to include a tiny "analog-tiger", which pounces when the real tiger does. The relevant "isomorphism" between computerised and biological visual systems is not a matter of physical properties as such, but of computational function.

These matters were not made clear by the early work on computer vision. This research was physiologically and psychologically implausible in a number of ways, and was fair game for Maynard Smith's "Pythagorean" criticism. It treated vision as though it were a matter of deductive problem-solving from stored schemata, or theorems. Moreover, it ignored most of the visual information that is actually available to seeing organisms (it worked with line-diagrams rather than real images or camera-input).

Recent work in computer vision, however, is very different. In particular, the late David Marr, working at the Massachusetts Institute of Technology, tried to integrate current neurophysiology and psychophysics with optical theories of image-formation. He argued that physiologists and psychologists will never understand the brain unless they can specify *what it is doing*. In the case of sight, it is carrying out a 2-D to 3-D mapping.

This specification of the basic task of vision helps us identify general constraints which apply to any seeing creature. These are *computational* constraints. They concern the "assumptions" the visual system must make about the world (for instance, that physical surfaces are smooth, by and large) in order to interpret changes in light-intensity in 3-D terms. A stripey image, for example, may be caused by a set of quasi-parallel physical objects (such as fence railings, or distinct strands of seaweed) or by one object with stripes on its surface (such as a tiger). If the visual system is to discriminate reliably between image-stripes caused by the edges of objects or by markings on surfaces, it needs to be able to exploit such constraints.

Maynard Smith might complain that we are no better off. Surely, an animal does not need to understand the theory of optics in order to see tigers, any more than it needs to know Pythagoras's theorem? Similarly, the brain needs no representation of physics, or of Greek geometry, in order to compute distances. Such ideas are biologically absurd.

The question is what one means by an animal "knowing" optics, or by a brain "representing" geometry. Certainly, it is not credible that mammalian brains use (conscious or even unconscious) representations of physical equations or geometric theorems as such, as a general-purpose digital computer can do. But this is not being claimed. One of Marr's main points is that the retina and visual cortex have evolved in such a way that they contain built-in, "hardwired" mechanisms capable of responding to the input light in broadly sensible ways. (Neuroanatomy tells us that these are more like massive parallel-processing computers than today's serial machines, and Marr's theory assumes parallelism accordingly.)

To be sure, the brain contains "representations" in some sense. Visual mechanisms do not merely *register* different intensities of light. They are interconnected so as to build up a series of higher-level "descriptions" of the image, the last of which functions as a 3-D interpretation (one which is independent of the position of the eyes). Marr's theory and computer models offer rigorous hypotheses about how this could happen. They are almost certainly wrong in detail, but this does not mean that the general approach is unsound.

The crucial point is that Marr's computational analysis has suggested ways in which the mammalian brain might use images to judge real distances, and allow for foreshortening. But there is no part of the visual cortex which is similarly foreshortened. Rather, there is a series of neural computations which enable the creature to see a wide range of things in a wide range of situations.

Hoverflies are less well endowed. They appear to have a built-in visual mechanism which judges the angle-of-approach subtended by a moving object and selects the insect's flight-path accordingly. Often, this results in the fly's encountering other hoverflies. But this mechanism cannot be used to help its owner fly towards any one of a variety of objects. The reason is that it is very rigid: in effect, it always assumes that the seen object has the same size and velocity as hoverflies normally do. This sort of mechanism might be analogically embodied in the insect's brain, as a single physical parameter which varies isomorphically with the flight-path of a real hoverfly.

For mammalian vision, however, this sort of isomorphism is not enough. We have radically different sorts of processes going on in our heads. There are many reasons for being thankful not to be a hoverfly, and this is surely one. ☐

Professor Margaret A. Boden is professor of philosophy and psychology at the University of Sussex and is author of *Artificial Intelligence and Natural Man* (Harvester Press).

The poisoning of Thailand

A visit to Thailand's slum drugstores reveals a horrifying trade in unsuitable and dangerous medicines. The government says it is trying to clamp down—but that is difficult when its own ministers are involved

Ed Harriman

"The boss, he gives us each one of the pills. At about 10 o'clock at night. Then after that my hands shake, my head becomes very awake. I work all night. Fast."

THE SPEAKER is a woman who works in a knitting factory in Bangkok, Thailand. She calls the pills she takes every night to stay awake *ya ma*, "horse pill" in Thai. They are amphetamines. "If you take too much they burn out your brains," the woman says. But it is difficult to refuse the drug.

The situation is not uncommon in Thailand. Addiction to *ya ma* is growing rapidly among lorry and taxi drivers, prostitutes and students, as well as factory workers. Dr Vichai Poshyachinda of the Institute of Health Research at Chulalongkorn University says that Thailand's 48 million people consume literally tonnes of amphetamines every year. I came across bottles of amphetamines in shacks in Bangkok slums. Yet officially, the problem does not exist.

Neither does addiction to diazepam (better known under the trade name Valium), although according to Vichai's studies that too is growing at an alarming rate. He has discovered that heroin addicts "have started to use injectable diazepam solution to dissolve heroin, or dissolve the tablet together with heroin in water and inject it intravenously".

Dr Vichai worked at the Middlesex Hospital in London before becoming a leading member of the Thai goverment's Food and Drug Administration's narcotics group. Yet despite these credentials, he has to be cautious. On Valium abuse, he will only go so far as to say "that preventative intervention is a real need to avoid the unnecessary loss of precious national resources and undue human suffering". He is even more circumspect about amphetamine addiction: "The existence of a nationwide problem without awareness of the problem is a most frightening hazard to the nation," he wrote recently. Privately, he says he expects little will be done.

The problem is that Thailand is ruled by what amounts to a military dictatorship. The generals are committed to free enterprise in virtually all areas of economic affairs, and nowhere more so than in selling drugs.

Business is booming. Anything that looks like medicine, that promises to make people healthy, live longer, gain weight, relieve aches and pains, is eagerly consumed. Thais spend more than 8 billion baht (£250 million) on drugs over the counter every year, according to the Food and Drug administration. That's about £5 per person in a country where farmers support their families on little more than £1 a day.

Ed Harriman

Official involvement?
Deputy premier Surat Osthanuckoa (top left) and deputy premier Bhichai Rattakul and tonics on sale almost everywhere in Thailand

In turn multinational pharmaceutical firms import their goods almost free of taxes, and export their profits at will. And government ministers are raking off huge profits from sales of some of the most popular, and least beneficial, medicaments sold.

Drug sales in Thailand begin just about anywhere on the street. When workers get tired they don't drop into the pub, or down a few mugs of strong coffee. In Thailand the universal "pick-me-up" comes in little bottles that look—intentionally—like medicine, called *Ktaing-daeng* and 'Lipovitan-D'. They and their rivals are sold everywhere in Thailand that caters to bodily needs; grocery shops, bars, chemists, massage parlours and street stands. Ten baht (30p) buys a 150 cc bottle of the wonder tonic. Men drink it before visiting brothels (common in Bangkok). Bus drivers take it to stay awake at night. And factory workers do the same. The national drink is local "Mekong" whisky mixed with *Ktaing-daeng*. And why not? after all it is claimed, among other feats, to prevent cirrhosis of the liver.

The trouble is that these tonics do not prevent cirrhosis; their food value is nil, and 10 baht is about one-sixth of a Bangkok factory worker's daily wage. The tonics are mildly addictive too, claims Dr Sumlee Jaidee, professor of pharmacological science at Bangkok's Chulalongkorn University.

"There's more food value in a cup of white coffee, and that costs a quarter as much," says Dr Sumlee. "People shouldn't be spending their money on bottles of syrup that do them less than no good at all."

But there is little chance that much will be done. Advertisements for the tonics are splashed all over Thailand. The companies that make them subsidise government signposts and hoardings. And the firm that makes Lipovitan-D, the Teck Heng Yoo Company, is controlled by Surat Osthanuckoa, Thailand's deputy minister of interior, and his family.

Surat's family also controls Osothsapha Co, which produces something a little more potent, and considerably more dangerous than wonder tonic. The trade name is Tamgai, and it is one of Thailand's two largest selling APCs (aspirin, phenacetin and codeine; the combined constituents of Thailand's number one painkiller).

Many of Thailand's 8 million farmers chew APCs, (or take a sachet in water) as some people chew gum, usually beginning just after breakfast and continuing into the night. "Most of our farmers are addicted to them," says assistant professor Suntaree Vitayanatpaisan of Chulalongkorn University. "Farming is backbreaking business, especially in the rice paddies, and the men need something to dull the pain." Many farmers spend at least 5 baht a day, a sixth of their income, on APCs.

Thailand's other leading APC is called *Baudhai*. It is made by the Jawarad Co, which is controlled by Bhichai Rattakul, a deputy premier. Though figures are difficult to come by, profits from APC sales alone for these two ministers' firms are estimated to exceed £15 million a year.

The trouble of course is that taken in quantity APCs are not only addictive, but also cause kidney damage and blood diseases such as haemolytic anaemia and methaemoglobinaemia (mainly attributable to phenacetin). "Many of our farmers have stomach ulcers from continually chewing APCs," says Dr Suntaree.

Doctors and pharmacists have lobbied for years to have phenacetin banned in Thailand because of the havoc APCs were wreaking on the population's stomachs and kidneys. The government finally agreed to a ban from 31 January this year.

But what looks like a victory for concerned doctors is at best only a partial one. The deputy premier's and the deputy interior minister's companies will stop distributing APCs. But as part of the deal they will continue to sell pills in the same popular packaging, which instead of APC will now contain paracetamol or aspirin.

"It's a step in the right direction," says an American-trained Thai government pharmacist working in Bangkok. "But any doctor can tell you that if you take 19 paracetamol a day, day in and day out, you're going to get stomach ulcers and kidney problems just the same."

Officially, the Thai government is committed to creating "health for all by the year 2000". As part of this, the Ministry of Public Health outlined a new National Drug Policy in April, 1981. Its main aim is to ensure the "supply of safe and good quality drugs at reasonable prices right up the rural areas," based on scientific assessments of the people's genuine need for drugs.

Tonics such as this do no good, and cost about one-sixth of a worker's daily wages

The policy was in part prompted by a critical report on the pharmaceutical industry in Thailand published the year before by the United Nations Asia and Pacific Development Institute. Based on information from the mid 1970s, the report's authors describe Thailand as a country where drug sales were horrendously out of character with the people's needs. The report points out that only a third of all drugs in Thailand are distributed with reference to any scientific criteria and that the consumption of psychotropics and analgesics (the so-called "comfort drugs") is growing faster than that of any others.

At the same time, the consumption of standard first-line drugs for treating tuberculosis abysmally low. "This just means that TB patients in Thailand are not treated," the authors wrote. "The same is true for antimalarials, where the consumption of chloroquine is about 7 per cent of what it should be."

The report concludes that "this trend foretells a widening gap between drug consumption and disease pattern where the former becomes increasingly autonomous and subject to market forces rather than to the ailments which originally generate the demand for drugs." In other words, people in Thailand are taking the wrong drugs, in the wrong doses for the wrong diseases.

Shortly after the Thai Ministry of Public Health announced its new drug policy, the World Health Organisation (WHO) submitted a report to the Thai government. It is restricted, but *New Scientist* has obtained a copy. Based on up-to-date research, the WHO's report was equally scathing about the effect of a free market drugs policy.

"Since Thailand follows a non-restrictive policy regarding imports, a large number of drugs not normally available in many countries can be purchased in the Bangkok drug market." In Bangkok, "most of the people avoid the long queues and cumbersome procedures in hospitals and seek treatment at drugstores where 'shotgun' therapy, involving the administration of multiple drugs, including potent ones, is resorted to."

Medical treatment is expensive in Thailand, so for anything more serious than a cold, most Thais simply visit the

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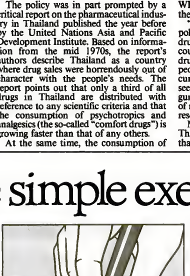

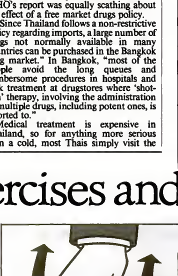

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chemist. Customers explain to the person behind the counter the symptoms of the person for whom the relief is intended, and the shopkeeper prepares a selection of pills which are then sold in small cellophane bags. Often, these are pill cocktails, popularly called *yachud*.

Some *yachud* are harmless; little packets of multivitamins and iron pills sold at anything between 5 and 20 baht per packet as a cure for tiredness and general malaise.

Yet some *yachud* are decidedly dangerous. Doctors and pharmacists at Chulalongkorn University have been collecting *yachud* brought from chemists around Bangkok and in the countryside. For gaining weight they have been sold anabolic steroids. For colds and influenza they have been given APC with Valium and/or Librium (a derivative of diazepam). For backache they have been sold assortments of phenylbutazone, a potent painkiller, with the steroids dexomethazone and prednisolone, along with, again, Valium and Librium.

Needless to say, there is no indication on the packets as to what the contents are, aside from indicating the symptoms for which they are to be taken. And buying them needs no recommendation or prescription from a doctor. There is also no indication as to whether or not the *yachud* are suitable for children. And yet the dangers of the steroids above are well known. Phenylbutazone can cause agranulocytosis—bone marrow deterioration—among other dangerous side effects.

Drugstores resort to "shotgun" therapy involving the administration of potent drugs, says WHO

Not one of the drugs in the *yachud* above can be bought in Britain without a doctor's prescription.

In the face of such evidence, Thailand's Food and Drug Administration has insisted that the indiscriminate dispensing of such powerful drugs has been effectively stopped in Bangkok and all but the most outlying villages. But this is simply not true. Most chemist shops in Thailand have no regular trained pharmacist; pharmacists are expensive to employ, and if chemists are forced to hire them, they will either close shop, or sell drugs by the back door.

It might be argued that Thai peasants and factory workers should know better than to buy little sachets of exotic pills from fast-talking shopkeepers. On the other hand that is what unfettered free enterprise, to which the Thai government is wholeheartedly committed, entails. The Food and Drug Administration is poorly funded and understaffed. Government officials will not discuss frankly the country's drug problems, let alone acknowledge the existence and extent of, for example, as amphetamine and diazepam abuse. And the multinational pharmaceutical firms keep their figures and their views to themselves.

Amphetamine abuse is a case in point, Britain's Wellcome Foundation originally sold amphetamines in Thailand; they are called *ya ma* or "horse pill," because each pill had the Wellcome unicorn symbol stamped on it. Wellcome withdrew the pill in the late 1960s, but today the deluge of blackmarket amphetamines, made locally and possibly imported from Hong Kong, still carry the counterfeit symbol.

Wellcome is not particularly fond of the association. Its manager in Bangkok insists that the company has nothing but the highest regard for the Thai Food and Drug Administration which, he says, "in difficult circumstances is doing an excellent job". Dr Vichai, who works for the administration, takes a more sobering view. "The truth is, there are very few people who are seriously interested."

In the meantime, despite his and other concerned doctors' and pharmacists' efforts, Thailand now had the dubious distinction of leading the world in two respects. It is still the world's main source of opium for heroin, it is a world leader in the newer phenomenon of "drug pollution" as well. □

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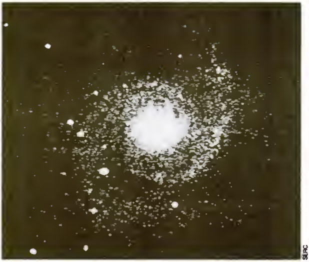
Helping Britain's Team to the Olympics

First light on La Palma

This week astronomers took the lens cap off Europe's largest optical telescope. The first pictures show pulsars, nebulae and galaxies

Nigel Henbest



The Whirlpool Galaxy, as seen by the Isaac Newton telescope's TV camera

SERC

BRITAIN'S foremost optical telescope has just taken its first pictures. The two new images shown here have come from a television camera connected to the Isaac Newton telescope on La Palma in the Canary Islands. The Isaac Newton is the largest telescope on European soil, and the first results have justified the claims of British astronomers that La Palma is among the best sites for an observatory in the world.

The Isaac Newton telescope was originally erected at the headquarters of the Royal Greenwich Observatory (RGO), in the grounds of Herstmonceux Castle, near Eastbourne in Sussex. This followed the recommendation of a Royal Society committee in 1946 that British astronomers should build a large telescope, to be named after the inventor of the reflecting telescope, Isaac Newton, whose tercentenary had been celebrated in 1942.

The misty climate of that part of Sussex did not matter much for the research on light from fairly bright stars that was important at the time.

It took 21 years to complete the telescope. By the time the Queen opened the telescope in 1967, astronomers' interests had turned to the distant and faint galaxies and quasars.

At Herstmonceux, the sky is always slightly hazy, and is lit up by the streetlights from nearby towns, so making it difficult to see the faintest objects. In addition, the atmosphere blurred images of stars to a size of about 3 arcseconds (about one-sixhundredth of the Moon's apparent size). So Britain's astronomers soon began to search for a better site—a quest that led them to the 2400-metre peak of La Palma in the Canaries.

Five years ago, the RGO closed the Isaac Newton. Its dome and the original mirror remain at Herstmonceux, but the telescope's tube and mounting were removed and taken to the Newcastle-upon-Tyne works of NEI-Grubb Parsons for refurbishment before being shipped to La Palma. During the past two years, engineers have reconstructed the Isaac Newton as the leading telescope at the new international Roque de los Muchachos observatory, set up by Spain (which owns the site) with Britain, Sweden and Denmark.

The observatory is perched at 2400 metres

Royal Greenwich Observatory

Britain's Science and Engineering Research Council is building three main telescopes on La Palma. As well as the Isaac Newton, there is a 1-metre telescope, now almost complete, and the 4·2-metre William Herschel Telescope, which will be finished in four years time. The Isaac Newton's move to La Palma has cost almost £10 million, with much of this expenditure going on the large building which will be the headquarters for British and Dutch astronomers who will man the observatory.

The move has meant some changes to the Isaac Newton. Politically, it is now a British-Dutch telescope: the Dutch have taken a 20 per cent share in the British telescopes on La Palma. Spain has been allocated a 20 per cent share of the telescope's time in return for providing the observatory's site and facilities such as power and telephone lines. Five per cent of the time will be devoted to international teams.

Physically, the most obvious change to the telescope is the mounting, which is tipped up. It must point toward the pole star, and, at the latitude of the Canaries, the pole star is 23° lower in the sky than in Britain. More important, it has a new mirror. The original mirror, 2·5 metres in diameter, was made of Pyrex. This material changes shape slightly with temperature alterations, thus blurring the image slightly. The Isaac Newton telescope now has a new mirror, made of a low-expansion material called Zerodur. It is also slightly larger, so the polished surface has increased from 96 inches to exactly 100 inches (2·54 metres).

For "first light", the telescope has been set up with a low-light level camera at the mirror's focus. Its first view was of the Crab Nebula, the remains of a star that exploded 900 years ago. Even without enhancement by a computer, the image shows the faint pulsar at the nebula's centre. The Isaac Newton then homed in on the Whirlpool Galaxy (M51), and its spiral structure leapt into view. The astronomers from the RGO turned to the galaxy NGC 4151, where they have recently found evidence for a black hole weighing as much as 100 million Suns, lurking in the compact nucleus. Finally they looked at the glorious glowing gases of the Orion Nebula.

The video pictures confirmed immediately that the steady airflow above La Palma hardly blurs the images of stars at all: they are no wider than one scan-line in the television system, corresponding to about 1 arcsecond in the sky. The starlight is thus concentrated into a crisp image with less than one-tenth the area of the blurred images seen at Herstmonceux. The astronomer in charge, Paul Murdin, says "all the promise is there, and I'm very pleased with that".

With computer enhancement, the television camera can "see" stars only one-millionth as bright as the faintest that are visible to the naked eye. The RGO's astronomers and engineers believe that this is the first time that a telescope has seen first light by video, and it has certainly proved effective.

During the observations, they were able

Bit by bit, the telescope was removed from its old dome at Herstmonceux

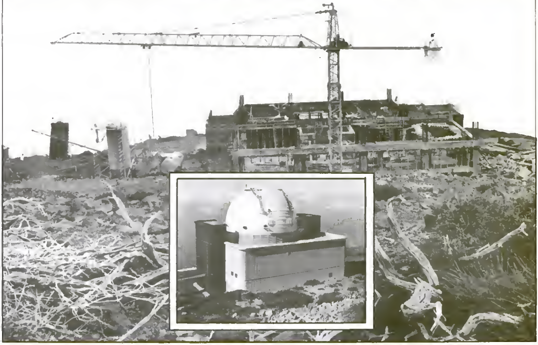
Pickfords

First view of the Crab Nebula and its pulsar, seen flashing on the video

SERC

Reinstalled on La Palma, the telescope shelters behind an up-and-over shutter

Royal Greenwich Observatory



The concrete structure of the main observatory building rises in 1980; inset shows the building and Isaac Newton dome today

Royal Greenwich Observatory

to check that the axis mounting was correctly aligned, and that the telescope was tracking the stars properly as the Earth turns. Although the engineers have still to fine-tune the tracking, Murdin says he is "very happy to see everything fundamentally working".

Once the telescope is fully in operation, astronomers will utilise this television system to home in on their targets: they will then use more sensitive detectors to "see" objects and record their spectra. The first detector will be a spectrograph mounted behind the main mirror to detect light with an "intelligent" Image Photon Counting System—an electronic intensifier linked to a television camera and computer. Dianne Harmer from the RGO will soon fix it to the telescope, and the spectrograph will see first light toward the end of March.

Although the RGO operates the telescope, all British and Dutch astronomers can use it, and regular observing will begin on 29 May when a Dutch astronomer, Hugo van Woerden, will take spectra of galaxies, followed by the director of the RGO, Alec Boksenberg. The telescope is already oversubscribed: the panel that allocates telescope time has had 63 applications for the first six-month period—amounting to 2½ times the number of nights available. Meanwhile, the smaller British-Dutch telescope has been named—and has also seen first light. This 1-metre telescope is specifically designed to take wide-angle photographs of the sky to measure star positions, and it has been named after Dutch astronomer Jacobus Cornelis Kapteyn, who pioneered the study of star motions from photographic measurements at the turn of the century. British, Dutch, Spanish and international teams share time on this telescope as well, and the Irish have 27 nights per year. ☐

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MONITOR

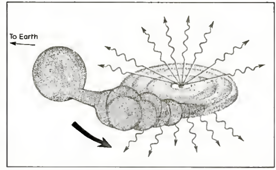
Eclipses shed new light on X-ray bursters

Ian Anderson, California

TWO American astronomers have achieved a feat that theoreticians had claimed to be impossible, and thereby discovered new facts about cosmic X-ray sources. They have found a star system where powerful bursts of X-rays from a neutron star are periodically eclipsed by a companion star rather like the Sun.

Their painstaking detective work over five years also unravels more of the mysteries of X-ray bursters—violent bursts of energy from near the centre of the Milky Way that were first detected in 1975. Thirty of these bursters, which are caused by gigantic thermonuclear explosions on the surface of the neutron star, have now been found.

But a dispute has also arisen over the significance of this latest work. Does finding the eclipse merely confirm what was already known or does it add significantly to our knowledge, possibly requiring revision of some old ideas?



A neutron star, only 6 km across (centre of disc at right), pulls trillions of tonnes of gas every second from the much larger, but lighter star (far left). As the gases sink below the surface of the neutron star, they burn unstably and emit bursts of X-rays (wavy arrows)

The work has been done by Lynn Cominsky, a research physicist from the Space Sciences Laboratory at the University of California at Berkeley, and Kent Wood, an astrophysicist at the US Naval Research Laboratory in Washington. Berkeley released details of their work last week, well before its formal publication next July in *The Astrophysical Journal*.

Cominsky and Wood studied X-ray burster MXB 1659–29 which is 30 000 lightyears from Earth. It was observed by two NASA satellites for two years in a row. Both satellites died in 1979. Most importantly, the two sets of data overlapped. This helped to plot the eclipse and to establish a cycle of stellar activity.

Scientists were baffled by X-ray bursters at first. Most were emitting violent bursts every 3-4 hours but some were truly haywire, erupting every few seconds. Massive black holes were initially suggested as their source.

But when it was discovered in 1977 that the radii of the bursters was only 10-20 km, many scientists concluded that they were coming from densely packed neutron stars which continuously ripped matter, mostly hydrogen, from a falling companion star. The two stars, linked by a massive accretion disc, whirl around one another in what is called a binary system, according to this model. X-rays are emitted constantly as the hydrogen falls to the surface of the neutron star. Helium forms below the hydrogen layer and when a critical combination of heat, pressure and density is reached, a thermonuclear flash occurs, sending out bursts of X-rays. The rapid bursts have been explained as "dribbles" of matter falling from the billowing hydrogen cloud onto the neutron star. Hard evidence for this generally accepted explanation has been lacking.

But in 1982 a team from Berkeley, Harvard and the University of Hawaii reported a regular pattern of "dips" or brief blockages in the reception of X-ray signals from source MXB 1915–05 (*Astrophysical Journal Letters*, February, 1982). These blockages occurred roughly every 50 minutes and were attributed to a stream of gas drawn from a companion star passing in front of a neutron star. But the researchers did not claim it was an eclipse of the neutron star by the companion star which unmistakably would have meant that two stars were involved in the X-ray burster phenomenon.

It has been generally agreed that an eclipse would never be seen no matter what the viewing angle. This view was based on the calculations of Israeli scientist Mordechai Milgrom who said that the companion star would either never pass between the Earth and the neutron star, or if it did, the X-rays being emitted would be blocked by the accretion disc.

Now Cominsky and Wood have detected an eclipse, something Cominsky claims will probably never be repeated. "It was actually harder than Milgrom said it would be—and he said it was impossible", said Cominsky. The companion stars are a lot smaller than had been predicted, she said. Also the mass ratio of the two stars was more extreme than expected—the neutron star is five times the mass of the companion star, not 1·5 times. "This made the eclipse smaller and harder to find."

Erratic fluctuations occurred in the X-ray signals for about 1½ hours out of every 7 hours. This was immediately followed by a 15 minute eclipse, as a sliver of the companion star blocked the neutron star from view. A steady, uninterrupted stream of X-rays followed until the fluctuations returned. The entire cycle repeated itself every 7·1 hours.

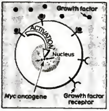
But how significant is the work? The disagreement is over whether or not it represents the definitive proof that X-ray bursters are in a binary system. Frank Shu, professor of astronomy at Berkeley, says that the two astronomers have indeed found the first direct evidence that a companion star exists. "It's like a murder mystery," he told *New Scientist*. "We had a corpse and a prime suspect and now they've found the smoking gun." But according to Walter Lewin, physics professor at MIT, there is no need for a smoking gun—the verdict was already in. "It's a nice piece of work, but it has changed nothing. It is of only minor consequence for our knowledge of the system," he said. (Lewin was the scientist who found rapid bursters and who first suggested that neutron stars were the source of X-ray bursters.)

But Cominsky is adamant. "Views will have to change," she said. The neutron star is heavier than expected—at least twice the mass of our Sun but only 16 km across. A piece the size of a thumbnail would weigh 2 billion tonnes on Earth. The companion star—about half the mass of the Sun—is smaller, fainter, lighter and cooler than predicted. Also the accretion disc is about 350 000 km thick and at least three times the size current models predict. Cominsky is confident of the conclusions because for the first time in an X-ray burster system, both the mass of the stars and the size of the orbit have been measured.

Jonathan Grindlay from Harvard, who detected the first X-ray burster in 1975, says that accepted theory can accommodate most of the new data although the idea that the neutron star may be heavier than two solar masses is "worrisome". "If that's true then it would cause trouble for theories on neutron star structure." The heavier the neutron star, the greater is its own gravitational inpull, and the smaller its radius. A neutron star heavier than three solar masses cannot exist, because its radius would be zero. But this very general limit may be too high; the actual value depends on how well the neutron's in the centre can resist compression, and recent calculations indicate the maximum mass may be as low as 1·8 solar masses. But Grindlay is about to publish work on X-ray bursters in globular clusters which suggests that neutron stars have a mass of less than two solar masses.

An exciting finding of the new work, he said, was that it indicated that the accretion disc fell away at its outer edges allowing the eclipse to be seen. "The work is also important because it gives us details of the end product of an X-ray burster. Now we have to find out how they got into that fix in the first place—that's the big unanswered question." □

How oncogenes keep cells growing



Initiation of the cell division programme

ONCOGENETICISTS will not have cured cancer by the end of 1984, but it is now odds on that they will be well on the way to understanding the central problem—which is what controls cell growth. Oncogenes are simply normal cellular genes that can be abnormally activated to produce an abnormal proliferation of cells. Last year's great leap forward was the discovery that one of the known oncogenes codes for a well-known growth factor—platelet-derived growth factor (PDGF). Now Mike Waterfield and his collaborators at the Imperial Cancer Reseach Fund in London, who were among those who made that discovery, have found that a second oncogene apparently encodes the receptor that enables cells to *respond* to a growth factor—a different one called epidermal growth factor (EGF). (*Nature*, vol 307, p 521). And almost simultaneously, a different team, working in America has shown that the growth factor PDGF activates yet another oncogene—this time one that probably acts directly on nucleus itself. What then is the pattern emerging from the intertwining of these separate strands?

The answer lies in the elaborate system that has evolved in many-celled animals to ensure that cells proliferate only as far as is appropriate for the needs of the organism. There are at least three components to this system: the signals (growth factors) that tell cells when to divide; the receptors sitting on the surface of the cell that bind the growth factors and transmit the "divide" signal to the interior of the cell; and the machinery at the heart of the matter—the programme of events in the cell nucleus that is initiated at each cell division (see figure). The operation of this central programme is usually under strict external control. For example, platelet-derived growth factor is normally produced only transiently, after damage to blood vessels, when it probably stimulates cells in the walls of the vessel to proliferate and repair the damage. It is normally not produced by the cells that have receptors for the factor and can therefore respond to it. When this system breaks down—as apparently happens in some tumours—and the PDGF gene is turned on in cells that bear PDGF receptors, the result is an abnormal self-stimulated and unstoppable proliferation.

The implication of Waterfield's new discovery is that there is more than one way for the growth-factor/receptor system to escape from normal regulation. He and his colleagues have found that one of the known oncogenes—known as *erb*-B (*erb* after the erythroblastosis virus in which it was discovered, and B because that virus carries two oncogenes, the other being *erb*-A)—encodes a part of the receptor for EGF.

The interesting point is that the part the oncogene encodes is *not* the part of the receptor that recognises and binds the growth factor on the outside of the cell; it is the part that is embedded in the cell membrane and, presumably, signals to the inside of the cell to start the growth programme rolling. This means that a cell with this gene activated will be equipped with an internal signal to keep growing, but will be deaf to the external signal that normally tells it when to stop and start. Waterfield and his colleagues have to assume that in the absence of the external part of the receptor, the internal part is permanently switched on. So cells in which this oncogene is active just keep silently kicking the growth machinery without reference to the outside world at all.

Meanwhile, the work of Phil Leder and his collaborators at Harvard and the Dana Farber Cancer Institute in Boston makes it look as though some tumour cells are even more introverted and have their nuclear division machinery permanently switched on, oblivious even to signals emanating from elsewhere in the cell. They looked at an oncogene named *myc* that seems to be activated in a wide variety of tumour cells. Nothing is known about the protein that it encodes except that it binds to DNA and so may be the nuclear trigger for division.

In which case, Leder and his colleagues reasoned, the *myc* gene ought to be turned on by any signal that makes a cell divide. To test that idea, they looked at three sorts of cells responding to three different signals. In each case, the activity of the *myc* gene was increased under the stimulus of the appropriate signal (*Cell*, vol 35, p 603).

What this shows is that the *myc* gene does indeed make a protein that initiates the division programme. And since in many tumour cells that gene is permanently activated, it may be that in those cells all external controls are overridden by regulatory abnormalities in the nucleus. The most spectacular example is seen in antibody-producing lymphocytes, the B lymphocytes, that can sometimes develop into Burkitt's lymphoma.

In normal B lymphocytes, antibodies are made at a very high rate and the site of the antibody genes is extremely active. In Burkitt's cells, it seems that the *myc* oncogene, by landing in the site of the active antibody genes, becomes highly active itself—and because the antibody genes are permanently switched on in B lymphocytes, the *myc* gene is permanently switched on in Burkitt's cells. It has bypassed the need for external proliferation signals by moving to a region of the DNA that is already active.

The wider implication of all this is that many more oncogenes may turn out to fit in this factor-receptor-nucleus circuit; some possibly as the intracellular links between cell surface and nucleus, and a full understanding of the division cycle and its control may soon emerge. ☐

Hello diquark, goodbye gluon

THREE Swedish physicists hope to start a controversy in particle physics by challenging the generally accepted picture of the strong nuclear force. This is the force that binds quarks within protons and neutrons.

The conventional view has it that the three quarks forming a proton move around quite freely, within the confines of a volume the diameter of a proton. There they exchange gluons, the "carriers" of the strong nuclear force that holds the proton together. But Sverker Fredriksson, Magnus Jändel and Tomas Larsson, from the Royal Institute of Technology in Stockholm, believe that two of the three quarks may be closely bound together to form a "diquark". They suggest that many effects previously ascribed to the existence of gluons can be accounted for by the presence of the diquark (*Physical Review Letters*, vol 51, p 2179).

Fredriksson and his colleagues say that to agree with existing data the diquark must be formed by two quarks spinning in opposite directions to form an object with zero spin. The dimensions of this diquark are much smaller than the dimensions of the proton, but significantly larger than a single quark.

Working from this basis the theorists were able to show that they could account for certain aspects of the scattering of electrons, muons and neutrinos from protons, without the need for contributions from gluons. Put simply, gluons are thought to carry some of the internal momentum in a nucleon (proton or neutron), and therefore contribute to the pattern of scattering of high-energy electrons. The Swedish physicists claim that "quarks and diquarks seem to carry the full nucleon momentum".

Still more remarkable, however, are the theorists' claims that their diquark model can account for even the "observation" of gluons in reactions arising from the annihilation of high-energy electrons and positrons (antielectrons). These experiments have revealed three jets—narrow sprays—of particles emanating from the collision point. Traditionally these jets are ascribed to particles materialising from a quark and antiquark; produced from the energy of the annihilating particles, together with a gluon radiated by the quark or antiquark.

In their model, Fredriksson, Jändel and Larsson presume that the annihilation can create a *di*quark and anti*di*quark. If one of these is not tightly bound it can break up into its two constituent quarks (or antiquarks), and so give rise to a total of three jets, as is observed in the experiments.

The Swedes furthermore suggest that this explanation provides the basis of a possible experimental test. In the diquark picture, the fastest of the three jets should come from the diquark, and should always contain a fast baryon—a particle containing three quarks, such as a proton. Such a finding, they claim, could not be accounted for in the conventional model. ☐

Parkinson's disease: an environmental cause?

MPTP is a by-product of MPPP, which north Californian addicts call "new heroin". By injecting themselves with the products of such a synthesis, addicts bring on all the symptoms of Parkinson's disease. This—and other cases almost certainly involving MPTP—has caused researchers to propose a new cause for parkinsonism and to develop an animal model of the disease (*New Scientist*, 3 March 1983, p 568).

The symptoms of Parkinson's disease appear only when large numbers of the neurons (nerve cells) in the part of the brain called the substantia nigra (SN) are destroyed. These neurons function by synthesising and releasing the neurotransmitter dopamine, which is present only in very small amounts—less than 20 per cent of normal—in the SN of patients. From these facts it was a short step to suggest that giving dopamine might improve the condition. As dopamine enters the brain only with difficulty, the amino acid dihydroxyphenylalanine (dopa), which is converted to dopamine by the enzyme decarboxylase, was used instead.

Fifteen years ago this neat solution to a long-standing problem appeared—like many drugs when first used—very promising. But, as is often the case, the treatment has not stood the test of time. Side effects have been found to be no fewer than with the much older treatments using atropine-like substances, and provide a fresh reminder that we just do not know what causes parkinsonism.

During the 1976 summer vacation a 23-year-old college student apparently succeeded in synthesising MPPP, which he then injected intravenously. It gave him an even better "high" than pethidine, which was one of the opioids he preferred after nine years of experimenting with a great variety of drugs. His success led him to raise the temperature and shorten the reaction time of the synthesis.

A few days of injecting himself with the products of this "sloppy batch" brought on muteness, akinesia, severe rigidity, tremor and a flat facial expression. Catatonic schizophrenia was first diagnosed, but anti-Parkinson drugs improved his condition markedly. Moreover, withdrawal brought a recurrence of the symptoms. As in classical Parkinson's disease the cells of his substantia nigra were destroyed.

Since that case, Donald Calne of British Columbia University and William Langston of Stanford University medical school have investigated eight more cases of addicts who have taken "new heroin", probably mixed with a high proportion of MPTP, who are suffering from parkinsonism and receiving treatment with dopa and dopamine agonists. Now a 37-year-old scientist involved in synthesising MPTP as part of his work with benzomorphine analogues has developed irreversible parkinsonism. As he was neither ingesting nor injecting the "drug", he must, suggest Calne and Langston, have absorbed it either through his skin or by inhalation.

When rhesus monkeys and squirrel monkeys received MPTP by injection, they suffered severe nigral cell loss which was accompanied by akinesia and rigidity that responded to treatment with dopa and dopamine agonists.

Langston and Calne suggest that this and other evidence points to environmental events occurring early in life as causes of the disease. These could be unnoticed infections or, more probably, exposure to a potent and selective neurotoxin like MPTP. Depletion of dopaminergic cells by the toxin might lead to a build-up of free radicals in the nigra that cause further damage. But the clinical features would appear only when the loss due to ageing reached a critical threshold (*The Lancet*, vol i, p 1457).

One of the virtues of the hypothesis is that it is testable. More than 100 young adults who have been exposed to MPTP have now been identified, and can be studied in the long term. In addition, monkeys can now be given small doses of the chemical, which do not produce acute effects, and can then be observed into old age. □

Passion vines lure ants with sweets

RELATIONSHIPS between insects and plants are commonplace. The best known involve pollination, where insects exchange their services as pollen transporters for a bit of nectar. Some plants, though, strike a closer alliance with their insect partners.

Symbiotic associations between ants and acacia trees—where the plant provides food and shelter and the ants provide a roving security force that repels nearly all invaders—are a remarkable example of coevolution between ants and plants. Acacias supply ants with nectar secreted from special glands at the base of each leaf. The ants often dwell in the hollow thorns of the plant and constantly police all parts of their living home, driving off the herbivores that would otherwise graze on the acacia. The ant's defensive activities are even directed against neighbouring vegetation; they trim away plants that come in contact with their home, ensuring that their acacia is not overgrown by competing vegetation.

Most relationships like this are found in the tropics and subtropics, and only a few examples of similar ant/plant associations are known to occur in temperate zones. One example of this kind of relationship occurring in temperate climates was recently described by D. Kelly McLain of Emory University in Atlanta, Georgia (*American Midland Naturalist*, vol 110, p 433). McLain observed an association between the passion vine (*Passiflora incarnata*) and a number of different ant species.

The passion vine, found in fallow fields and along roadsides in the southeastern United States, is a perennial species that produces large, showy flowers in late spring. Like acacias, the passion vine has nectaries associated with its leaves. The nectar glands of this species of *Passiflora* occur in pairs on the leaf petiole, and paired nectar glands are also found on the bracts at the base of flowers and buds. While floral nectaries produce nectar only at specific times during the day, the extrafloral nectaries of the passion vine secrete nectar continually. This constant nectar supply is an important factor in attracting large numbers of ants to the passion vine.

McLain noted that five species of ants visited *Passiflora* vines during the course of the day to take nectar from the extrafloral nectaries and that the visits of the different species rarely overlapped, providing the plant with continuous protection by ants. The ants visiting the passion vines attacked flies, beetles, and grasshoppers, effectively preventing these insects from feeding on the leaves, buds, and flowers of passion vines. When the nectar-producing glands were removed from a plant the number of visiting ants decreased, while the rate of grazing by herbivorous insects increased. Plants protected by ant defenders produced more fruit than unguarded plants, and the ants were even observed pruning away old leaves that were no longer producing nectar. In one plant the ants had taken up permanent residence in the hollow stems of the passion vines, providing a live-in security force.

How does the protection provided by ants for their home plant compare with other methods plants have evolved to defend themselves against insect attack? Plants produce a number of toxic and noxious compounds that presumably repel herbivores. Alkaloids, resins, tannins, and a variety of other compounds are thought to provide plants with a chemical armoury. The substances secreted by the extra-floral nectaries of the passion vine and the acacia might also be regarded as a chemical defence, because this nectar production ultimately plays a role in discouraging grazers. The synthesis of the simple sugars and amino acids that constitute nectar may even cost the plant less energy than the production of more elaborate chemical compounds used for defence.

If the plant uses strictly chemical deterrents then enough of the toxic substance must be produced to render the entire plant unpalatable. If ants are employed in the plant's defensive strategy, however, only enough nectar to attract sufficient defenders is needed. McLain and others have also pointed out one other advantage for using sweets to attract an active, mobile defence force. It is probably far more difficult for a herbivore to evolve a defence against a horde of biting, stinging ants than it is to evolve the physiological changes needed to adapt to simple chemical changes. □

TECHNOLOGY

Engineers seek to tap gas in deep water

Michael Cross, Stavanger

IMAGINE the Eiffel Tower turned upside down. Give the base enough buoyancy to make it float in seawater. Attach the top to the sea bed with a giant universal joint, and build an 11-storey industrial complex on the floating base.

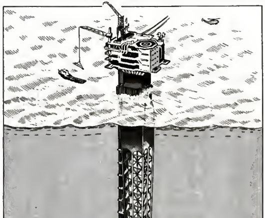
This is one of the ideas that oil companies, which are keen to open up a new generation of oil and gas fields under the North Sea, are seriously considering. Companies see the platforms as logical extensions of the structures they have already built in the North Sea.

Early platforms, such as the Ekofisk complex, in 75 metres of water, were rambling affairs, with equipment for drilling, production and living quarters on separate steel or concrete platforms fixed to the sea bed.

As production platforms moved to deeper waters, up to 200 metres, they evolved into single structures, with people living and working on the same platform. The most northerly platform in the North Sea, BP's Magnus, which sits in 186 metres of water 200 kilometres north of the Shetland Islands, is of this type. So is the newest platform, which is due to float out to Statfjord in the Norwegian sector any day now.

However, these larger platforms may have reached their limits. The world's largest platform, in the Gulf of Mexico, stands in 312 metres of water and is the same height as the Empire State Building. But even that is not tall enough for the fields that will have to be developed in the North Sea if Europe is not to run out of gas by the 1990s.

The name that gets everybody excited is Troll. This is a vast gas field off north Norway, in 350 metres of water. Tapping its gas will require a new generation of equipment.



To work in the Troll field, a conventional platform would need 800 000 tonnes of concrete, and be the biggest and heaviest mobile object ever built. It would cost something like £5 billion. One company that has been looking at the possibility of building such a structure is Elf Aquitaine Norge. Its managing director, Pierre Chouzenoux, describes the idea of a 350-metre fixed structure as economically "completely crazy".

One way to reduce the cost of the project would be to allow the platform to move with the waves, rather than resist them. This is the thinking behind the "upside down Eiffel Tower". According to Elf Aquitaine's engineers, such a platform attached to the sea bed with a universal joint would weigh only one third as much as a fixed structure, and be far cheaper to build. There is, however, a snag: engineers calculate that a flexible, or compliant, platform can carry only 30 000 tonnes of living quarters and equipment on top. The equipment needed on a single Troll platform would weigh 60 000 tonnes. The way around the problem would be to build a single fixed platform and a network of compliant platforms, but this would be economical only on a very large field.

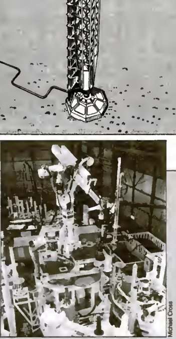
Unfortunately most engineers in the oil industry agree that future offshore ►

THE most important quality of subsea equipment is reliability. While divers can and have done jobs 300 metres down, working that deep is slow, expensive, exhausting and dangerous. In the words of one North Sea diver: "Anyone who is honest will tell you he is scared to death at that depth".

A huge and complicated structure taking shape in a shed south of Bergen in Norway could relieve divers of some of that anxiety. The idea is to build a network of wellheads, which robots can assemble and maintain on the sea bed.

The first objective of the project, called Skuld, is to find a way of developing marginal offshore fields a long distance from surface facilities. But the engineers behind Skuld hope to open the way to complete oilfields without platforms—the logical way to work in very deep water.

The Skuld machine, now being assembled by Elf and a group of Norwegian companies, consists of a template which will sit on the seabed and a cluster of modules containing four Christmas trees (wellheads) and the hydraulic and electrical equipment to control them. Power for the whole thing comes through an electrical cable running along the sea bed.



Michael Cross

Subsea wellhead nears completion

The idea of modules is important. What the engineers want is a device that a remotely controlled robot can assemble at depths of over 300 metres. Parts have to be interchangeable and easy to remove for servicing at the surface.

When this needs to be done, a support ship will lower a robot module, which sits on top of the other modules. It has a telescopic crane, with a video camera, to manipulate components and bring them to the surface.

The Skuld rig will undergo tests in shallow water in the middle of April, then be lowered 100 metres into a fjord where it will remain for a year. During this time engineers will work the different valves and controls to simulate five years of operation at 300 metres.

Only after Skuld has proved that remote wellheads can survive and operate normally—and can shut off instantly in the event of a "blowout"—will they go to work on the bed of the North Sea. □

▸fields must have fewer, not more, platforms. The way to achieve this is to put the equipment on the sea bed. Manned capsules hundreds of metres down are many years away. But the technology of remotely-controlled wellheads at the bottom of the sea is advancing rapidly. Elf is developing a system of wellheads that robots can build and maintain 400 metres down (see Box on previous page).

Although the new technologies are intended to exploit large oil and gas fields, the impetus for their development comes from small, so called marginal, fields. These small fields, once thought not worth exploiting, present the same basic problem that deep fields will: it is not worthwhile to build a single fixed platform.

One marginal field that has become a kind of test bed for new technology is North East Frigg, halfway between Britain and Norway. The field is 18 kilometres away from the main Frigg complex, which has been producing gas since 1977. North East Frigg accounts for only 4 per cent of Frigg's reserves. At most, it could produce 7-8 million cubic metres of gas a day. So Elf Aquitaine Norge, which operates the Frigg field, could not justify building a fixed, manned platform on the site. Instead, the company's engineers decided to put as much of the equipment as possible on the sea bed, 100 metres down.

Subsea wellheads are not simply holes in the ground. The array in North East Frigg consists of six wellheads to monitor and control the gas coming out.

Such subsea wells are not new in themselves. Many platforms have satellite wells a few kilometres away from the main platform, controlled with hydraulic pipes. But direct control does not work over 18 km because the wellhead would take too long to respond to hydraulic signals.

The only way to control northeast Frigg from the main platforms would be to send electrical signals to hydraulic pumps near the wellhead. This could be done by laying high-voltage cables along the sea bed, but the engineers decided that such a set-up would be unreliable. Instead, Elf's engineers built a small unmanned platform on a compliant column (fixed to the sea bed with a universal joint), 150 metres from the wellhead. A conventional pipeline carries the gas 18 km to Frigg for processing.

The whole set-up cost £200 million, a fraction of the cost of a conventional platform. Jacques Bosio, deputy research manager of the Elf group, contrasts the development with a conventional platform being built for another satellite field nearby, called Odin. This field, which will start production in a few weeks, will produce 10 million cubic metres of gas a day but will need 24 workers permanently on station. Running North East Frigg will need a crew of seven, living on the main Frigg complex.

These considerations, although important to the accountants, do not amount to much beside the scale of investment in the North Sea (BP spent £1·3 billion developing the Magnus field). But to engineers, the new technologies have a different meaning. "We could have developed North East Frigg with a conventional system," Bosio says, "but it is our policy to install something new. □

Report clears "dangerous" cement

HIGH alumina cement (HAC), which became notorious in the 1970s, was given a clean bill of health by the Building Research Establishment in a report published at the beginning of February. Dr Stephen Bate, a consultant, says in the report that prestressed concrete buildings with HAC beams and joists ought to last their normal lifespan. But, damp buildings where the concrete is inferior and heavily converted from its original hexagonal crystals to cubic ones are still suspect.

Bate says that recommendations made about building appraisal and testing in the mid-1970s hold good today and that no further research into low-grade HAC is needed. Attention, he says, should now go to Portland cement and higher grade HAC designed for environments subject to chemical attack.

HAC became notorious after roof beam failures at two London schools; the Camden School for Girls and The Sir John Cass and Redcoat School at Stepney. The beams in the Stepney school were found to have converted to a degree far beyond that considered normal for HAC.

HAC came into its own with the construction boom of the 1950s and 1960s. Its main advantage was the speed at which it dried and at which it gained full strength. What was often not appreciated, however, was how crucial the ratio of water to cement was, and how much a high setting temperature weakened the eventual strength of the cement.

There have been, says Bate, serious misunderstandings of its behaviour and contradictions in the advice given to engineers during the past 50 years.

Other European countries—Hungary and West Germany among them—banned HAC in the mid-1950s and early 1960s. By 1970, France had set a strict total water to cement ratio of 0·4 and had prohibited use of alkaline fines with HAC. In 1972, Britain issued a code of practice (CP 110) that allowed a water ratio 20 per cent higher than the French standard and laid no emphasis on avoiding aggregates that could release alkalis.

Given that there have been no more failures, engineers are reasonable confident that existing buildings are safe, subject to careful monitoring. However, standard beam tests will not discover cores where the concrete has converted totally and lost all strength. Whether these beams and joists last the course will depend on the strength of other parts of the building. □

High alumina cement concrete in existing building superstructures. Building Research Establishment Report 1984. DoE. HMSO £4·85.

Honeycomb replaces drip board

A BRITISH company—Celestion—is making loudspeaker cabinets from a material developed for aircraft cabin floors. A sandwich of aluminium sheets with a honeycomb core filling is just what is needed for a speaker cabinet; very light but very strong.

Conventional loudspeakers are made out of wood chip board, structurally braced to prevent energy loss through cabinet vibration. If the loudspeaker walls were light and thin the sound would be distorted because of natural resonances.

Celestion is mass-producing cabinets built from sheets of the honeycomb-cored aluminium. This material does not add unnatural emphasis to certain frequencies because of resonance. The honeycomb panels makes Celestion's SL600 speakers 50 per cent lighter than their chip board equivalents.

Japanese firms already use flat honeycomb sheets for the moving diaphragm of a loudspeaker. They will love the idea of a cabinet made from the honeycomb sheeting because it is expensive to export large loudspeakers which have traditionally been very heavy. □

Helicopters look out for lasers

THE US Army is planning to install laser-warning receivers on its helicopters. The receivers will alert the crew when the helicopter is being illuminated by a laser beam from a target designator or rangefinder. Such illumination is likely to be the prelude to an enemy attack.

Laser designators first became popular during the Vietnam war because they could guide missiles and bombs to their targets with great accuracy. A soldier equipped with a laser designator illuminates a target with a coded series of pulses that an electronic sensor can home in on.

The laser-warning receivers are part of a US effort to develop countermeasures to foil laser-guided weapons. No details are available on the receivers but researchers have already demonstrated the ability to identify laser wavelength and the direction from which the laser-beam came.

If the laser wavelength was known, troops under attack could use a similar laser to try to blind the electronic sensor trying to find them. If the beam direction was known, they could start shooting at the soldier holding the designator. The warning indicator itself would probably be part of an integrated system that also warns when a helicopter is illuminated by radar. □

In search of early warning

Japanese medical file saves time

JAPANESE researchers have come up with a new way of putting digital information on a magnetic tape which has led to a scheme to standardise the storage of personal medical histories.

The scheme forms part of the Science and Technology Agency's research on ways of dealing with the problem of Japan's increasing number of old people. Average age is increasing faster than in other industrialised nations. Free medical care after retirement plus the ever-growing tally of available tests are causing the government's medical bill to rocket.

Under the proposed scheme, all a person's medical data, for example, X-rays, electrocardiograms and the results of blood or urine tests, would be stored on the same magnetic medium—probably a disk. People would keep their own disks, which they would take with them to the doctor.

Not only would doctors be able to get their hands on correct information more efficiently, they would also be able to give a better diagnosis through comparision with previous results. And tests done at one hospital would not need to be repeated.

How the information is to be recorded is the responsibility of Professor Shunichi Iwasaki of the Research Institute of Electric Communications at Tohoku University. For the past seven years he has worked on overcoming the limitations of conventional methods of storing data on magnetic media. His solution is to stack digital pulses upright instead of laying them out horizontally. Iwasaki says that by using this method it is possible to increase the amount of data recorded by as much as 10 times.

To ensure that the hardware used to implement the method will be standardised, eight electronic equipment manufacturers have formed a joint development group. And the Japan Broadcasting Corporation is working on a high-resolution display.

The scheme will be tried out over three years. beginning in 1986. Before it starts, however, several technical problems—such as how to turn X-rays into digital signals—remain to be solved. ☐

YOUR RECORD DISC HAS MADE THE TOP TWENTY
PEYTON

Army tests new tag

NAME, RANK AND NUMBER, as any war movie fan knows, is all that the captured British tommy is prepared to give away under interrogation. Not so the modern American GI, because the US army is considering issuing troops with machine-readable "dog tags" which contain a complete dossier on the wearer.

The tags, which can be read by a small computer, have already been tried out on 3000 members of the 9th Infantry Division, otherwise known as the high-technology Light Division, and charged with developing new technologies for the military.

The 9th Infantry tested the tags during an exercise called Lasermace. They are similar in size to existing metal tags, and have sufficient memory to hold information about medical history, army record and financial position.

In the exercise the tags enabled the officers to determine the number of "casualties" and to speed medical records to field hospitals. The army also hopes that the tags will cut down the paper work involved in transferring soldiers. ☐

Computing pyramids

CLEVER COMPUTER WORK by French researchers looks like bringing Egyptology to the masses. At the moment only Oxford University and the French Institute of Oriental Archaeology in Cairo are able to print hieroglyphic texts. The variations in size and direction of the 7000 signs commonly found in hieroglyphics means that it takes something like a week to set up eight to 10 lines of text. This means around 108 years to publish the hieroglyphics contained in nine Egyptian pyramids.

Now a Frenchman, Michael Hainsworth, has devised a system to turn each hieroglyph into digital signals. This is done by making a video picture of the hieroglyph and storing it in a microcomputer. The character can be digitised in five to 10 minutes when displayed on the screen. It can then be manipulated or printed on a standard plotter connected to a central computer.

The original idea was for the micro to analyse and search through the text. Printing was only a secondary application. But given the huge cost of printing with conventional methods (about £80 per 300-page book in a 300-book run), the new system may have a commercial future. Instead of the 108 years needed to print the hieroglyphs in the nine pyramids, the new method will take 10 years. ☐

India in space

WEST GERMAN equipment for studying cloud dynamics, heat radiation and remote sensing will be orbited on board an Indian space craft in 1985. The 150 kilogram craft is being designed to go into a 400 kilometre high circular orbit. Scientists are working out details of an agreement between the two countries.

Meanwhile India is negotiating another agreement with France to receive information from the French earth observation satellite (SPOT)—due to be launched in 1985. ☐

Does the brain have a mind of its own?

Are love, fear, sorrow or memory simply electro-chemical reactions?

Or is there an extra, spiritual dimension to the billions of neurons fizzing away inside our skulls?

On Wednesday at 10.45pm on Channel 4, two of the world's leading thinkers stretch their brains around this age-old problem.

Future programmes in this series of ten will feature the world's top intellects debating at the ceiling of their intelligence.

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4

Sink or swim in the technology pool

John Bell

UNIVERSITIES and industry are taking advantage of research by creating a technology pool. At the 1984 Techmart Awards—for successful examples of technology transfer—one of the entries vying for a prize is a switched-reluctance motor. It was developed by the universities of Leeds and Nottingham, and is being made under licence by 10 companies worldwide who are committed to pooling information about the motor.

The motor is claimed to be 50 per cent more efficient than conventional designs and can be programmed to respond to changing loads and operating conditions.

Once the two universities had demonstrated the machine's potential, they formed a company to exploit their work through design and licensing agreements. The company, SRD Ltd, transfers complete designs to the 10 manufacturers for production. This setup is the technology pool, and it has very strict rules. Every manufacturer must sign a secrecy agreement and contribute everything discovered in the development of the product. In return, all pooled information is freely available to each licensee.

But arranging the pool was not easy. Peter Lawrenson is the professor of electrical and electronic engineering at the University of Leeds. He said that persuading the licensees to pool their efforts was a "psychological problem". Guaranteeing each a unique market, electric vehicles or mining, for example, helped them to cooperate. Said Lawrenson: "I would certainly advise others to try the idea. I am convinced that these pools could be very important for this country."

The switched-reluctance motor is one of three finalists for the Technology Transfer Trophy, awarded by the British Technology Group. The other two are multiplexed electronic wiring systems for motor vehicles, developed at Salford University, and a mass spectrometer from University College of Swansea.

Besides these contestants another 11 entrants will compete for four other awards. The winners will receive their trophies on 21 February from John Butler, under secretary of state for industry, at the Techmart exhibition in Birmingham.

The Techmart Inventor of the Year Trophy, presented by the Institute of Patentees and Inventors, will reward technology transfer from an individual to a company. Kenneth White, of Retford, in Nottinghamshire entered a process for turning fibrous waste, such as straw, into packing and building materials.

White's Strawbox plant will have applications in developing countries as well as helping to reduce the clouds of smoke that drift across motorways at harvest time. A prototype has been built by Marshall Sons Co, Gainsborough, a firm that has made agricultural machinery for more than a century.

Fibrous waste such as straw can be turned into packing and building materials

The basic machine, which costs about £75 000, takes in raw material at one end, chops it and sprays it with isocyanate resin, heat cures the mixture, and delivers a standard size board. The boards are 2·4 by 1·2 metres and up to 6·4 centimetres thick.

David Wilson, in charge of marketing Strawbox, says: "The main sales potential is overseas for packaging, pallets and furniture making. Strawbox is about as technically sophisticated as a bailer. We reckon it can be maintained and repaired with nothing more than a heavy hammer."

Marshall has considered mounting the 23 m Strawbox on a train and taking it where straw is plentiful. But he says that British Rail was not too enthusiastic about the idea and Strawbox plants, certainly in Britain, will have to stay put.

The other finalists for the inventor of the year award are an instrument that measures small objects in three dimensions, which was entered by Peter Scott of London, and a drawing instrument for schools designed by D. C. L. Griew of Littlehampton.

Schools have their own Techmart trophy. It is awarded by the Department of Trade and Industry to "the secondary school which has done most to encourage technologically oriented links with industry". One interesting finalist is Caerleon Comprehensive in South Wales, a place full of innovative ideas about science education (*New Scientist*, 24 November 1983, p 584).

Caerleon and other Welsh schools have devised a "pupil profile reporting scheme" with the direct involvement of industry. Each pupil leaves school with a profile, produced by teacher and child.

Caerleon's headmaster, Lew Lapham, says that the scheme has "catalysed" other links between schools and industry. They include exchange schemes involving industrialists, teachers, children and parents.

The fourth trophy is awarded by the Confederation of British Industry. It is for success in marketing advanced technology. One finalist, Thorn EMI Datatech, has sold a high-density, digital-recording system to NASA. The system's success in recording data from space shuttle flights has won it a NASA "Certificate of Achievement".

Phil Seward, Datatech's export manager, believes the system succeeded because it can change recording levels from 100 kilobits per second to 50 megabits per second in less than 20 seconds without any manual adjustment. He said: "Previously, the success rate in recording data from space missions has been low because of necessary adjustments. Our system is automatic so missions can transmit data at different rates at short notice."

The other finalists are a range of flares for the oil industry from Kaldair, Feltham, and a system of superconducting magnets made by Oxford Magnox Technology.

The final trophy will be awarded by Barclays Bank, which sponsors Techmart. The High Technology Venture Award is for the technology company "most likely to succeed". There are two winners, ABCO Technology, which builds energy-conservation systems for industry, and Warwick Computer Designs, a firm supplying machine control systems. ☐

Peter Kennard

Old age can kill the Bomb

Atomic bombs need tritium, a radioactive isotope of hydrogen which decays rapidly. If nuclear weapons are starved of tritium, the superpowers' stockpiles will gently wither away

Tom Wilkie

"WE ARE HERE to make a choice between the quick and the dead. That is our business. Behind the black portent of the new atomic age lies a hope which, seized upon with faith, can work our salvation. If we fail, then we have damned every man to be the slave of Fear. Let us not deceive ourselves: We must elect World Peace or World Destruction."

Speaking to the United Nations Atomic Energy Commission with these bombastic words on 14 June 1946, US ambassador to the UN Bernard M. Baruch proposed an American plan for the complete abolition of nuclear weapons.

The plan failed. Led by a certain Andrei Gromyko, the Soviet delegation could not accept any proposal that would legitimise, even temporarily, an American monopoly on the Bomb. Equally unacceptable to Stalin's Soviet Union was the proposal that international inspectors would regulate and monitor all the USSR's nuclear activities. The world thus lost possibly its only chance of ridding itself of nuclear weapons. Since then, in Baruch's terms, everyone has been the slave of fear. We have not elected World Peace, but we have avoided World Destruction—so far.

The existence of nuclear weapons has petrified the world's political system into the pattern set at the end of the Second World War. But if the political situation has remained surprisingly static, the technical problems confronting any new proposal for nuclear disarmament have grown immensely. At the time of Baruch's proposal, the US had at most nine nuclear bombs—all in bits and pieces, none immediately usable. No other nation was then in possession of atomic weapons. Today, there are nearly 50 000 nuclear warheads distributed around the globe. Five nations—Britain, China, France, the US and the USSR—have unquestionably mastered the art of nuclear weaponry; several others are believed to be capable of building atomic bombs. India exploded a "peaceful" nuclear device in 1974, and Israel is believed to have a stockpile of bombs ready for assembly.

One of the greatest stumbling blocks to any proposal for nuclear disarmament today is the issue of verification. How could any nuclear weapons state be confident that an adversary was sticking by its undertaking to dismantle its nuclear stockpile? Given the size of the nuclear stockpiles the problem seems insuperable, but the laws of physics will do the job: if nuclear stockpiles are denied tritium, they will decay radioactively.

The US has a stockpile of more than 26 000 nuclear warheads, according to the *Nuclear Weapons Databook* published by the Natural Resources Defense Council earlier this year. Well over 200 000 people and an annual budget of over $35 billion are involved in development of new weapons, production of existing types, and care of those already in the stockpile. The US is currently turning out about eight new warheads a day, and the stockpile will rise to 32 000 warheads by 1990.

The US possesses an incredible range of nuclear weapons. The are 24 different types of warhead in the stockpile. The most destructive is the W53 which sits atop the Titan missile and is capable of delivering 9 Megatonnes of explosive power to its target. As the bomb which devastated Hiroshima was a mere 12 kilotonnes, the W53 has a destructive power of about 800 "Hiroshima-equivalents". The heaviest warhead in the armoury is the companion to W53, the B53 bomb which weighs 4 tonnes and is 3·67m long and 127 cm in diameter. If used in anger, the bomb would be carried by the B52 bomber and dropped onto its target. Each of the 150 B53 bombs in the US stockpile also has a destructive power of about 9 Mt. (Both weapons are in the process of being phased out and replaced with more accurate systems.)

But bomb designers are very creative: at the opposite end of the scale is the Special Atomic Demolition Munition, more commonly known as the "nuclear landmine". This weapon, which packs a destructive power of less than 1 kt, weighs only 26 kg. It is so light, a soldier could carry it in his rucksack. There are 300 in the US stockpile.

For obvious reasons, no one knows in the same detail the size and variety of the Soviet stockpile of weapons. The Stockholm International Peace Research Institute (SIPRI) has compiled figures from several sources, and the consensus seems to be that the USSR has about 17 500 warheads; US estimates, however, put the figure close to 23 000. The Soviet Union has certainly set off the biggest single man-made explosion in the world. In a test in October 1961, the Soviet Union exploded a 58 Mt weapon in the atmosphere. Samples

BNFL

Chapelcross made Britain's plutonium and now makes its tritium

The gold-plated nuclear deterrent

ALL NUCLEAR weapons derive their explosive energy from the fission of nuclei of very heavy atoms, or from the fusion of nuclei of very light elements, or from a combination of both.

In practice, the only fissile isotopes from which fission weapons can be made are uranium-235, uranium-233 and plutonium-239. Uranium-238 and thorium-232 are both fissionable by fast neutrons, but they would not contribute to a self-sustaining chain reaction, so they are not used in the fissile cores of nuclear weapons. They do have other uses, however, and contribute significantly to the yield of thermonuclear explosives.

Popperfoto

The bomb which destroyed Hiroshima used highly enriched uranium, and the "gun" type of design

In its natural state, uranium occurs in two forms (isotopes) which differ from each other in the number of neutrons present in the atomic nucleus. Uranium-238 forms 99·3 per cent of all the uranium found in the Earth's crust, and ^{235}U the other 0·7 per cent. Plutonium occurs naturally only in minuscule amounts and has to be bred from ^{238}U in a nuclear reactor. According to Dr John Simpson's book *The Independent Nuclear State*, Britain has produced about 43·8 tonnes of plutonium since its programme (military and civil) began.

In a similar manner, ^{233}U can be bred from thorium-232 in a nuclear reactor. But, although the US has tested weapons made from ^{233}U, the material is more radioactive than the other fissile isotope of uranium and this would complicate weapon design, so nuclear weapons in the stockpile are all made from ^{235}U or ^{239}Pu.

Weapons-grade uranium is made by "enriching" the naturally occurring material to 93·5 per cent or more in the ^{235}U isotope. In producing weapons-grade plutonium (93.5 per cent ^{239}Pu), the period of time that the ^{238}U is left in the reactor is limited, to restrict the build-up of other isotopes (^{240}Pu and ^{241}Pu) to less than 6 per cent. The reactors at Calder Hall next to Windscale and at Chapelcross on the Solway Firth have produced about 2·7 tonnes of weapons-grade plutonium for Britain's military nuclear needs. Until 1964, the reactors produced electricity as a by-product of plutonium production. Since then they have operated on a civil fuel cycle which does not produce "weapons-grade" plutonium.

The critical mass of a bare sphere of normal-density ^{235}U is about 52 kg, and that of plutonium ranges between 10 kg and 17 kg, depending upon the metallurgical structure. However, if it is surrounded by a material which reflects escaping neutrons back into the sphere, then the critical mass can be reduced by a factor of two of three. A suitable neutron reflector is beryllium.

A second method of reducing the critical mass is to compress the material to a much higher density. Most of the weapons in the American nuclear stockpile are believed to require only a fraction of the critical mass at normal density—known in the trade as "fractional crit" weapons.

The nuclear explosion is set off by the "implosion technique". Such weapons consist of concentric spheres of material. At the centre lies a hollow sphere of fractional crit fissile material. This could be weapons-grade uranium or plutonium – in more advanced designs, there are actually two spheres, the inner one consists of plutonium and the outer of uranium; with suitably chosen proportions, the critical mass of the mixture can be lower than the mass for either of the elements on its own.

There is a gap between the outer surface of the fissile material and the next concentric sphere. The material of this sphere, the "tamper", is a mixture of ^{238}U and beryllium. The tampers for Britain's bombs are manufactured at the Royal Ordnance Factory at Cardiff. One of the tamper's functions is to act as a neutron reflector. It is in its turn surrounded by a peripheral charge of chemical high explosive. In Britain, the separate components are assembled into a complete warhead on the production lines at the Burghfield Royal Ordnance Factory.

When a bomb explodes, the chemical high explosive is detonated uniformly to create a spherical pressure wave that drives the tamper inwards onto the fissile core. The tamper picks up momentum as it crosses the empty gap, and fulfils its second role as it hits the fissile material with a huge hammer-blow. The process creates overpressures of millions of pounds per square inch in the fissile core, increasing the density by more than a factor of two and thereby making the previously subcritical mass supercritical. At this moment, an external source of neutrons is switched on, and sprays the supercritical mass with neutrons. In less than half a microsecond, the chain reaction which the external neutron source has initiated has fissioned $1 \cdot 45 \times 10^{23}$ nuclei, yielding a one kilotonne explosion. (This consumes approximately 57g or 2 ounces of fissionable material.) The complete fission of 1kg of material will produce a 17·5 kt explosion. Stray neutrons from the chain reaction are mopped up by the ^{238}U in the tamper which fulfils its third function by contributing further to the explosive yield.

A second design of fission device is the "gun" technique, whereby a subcritical mass of fissile material is shot down a tube into a second subcritical mass. The bomb that destroyed Hiroshima was of this type. In general, however, the implosion device is more "efficient" (that is, one gets more explosive power from the same amount of material) and plutonium bombs cannot be made by the gun technique. Almost all modern weapons, therefore, use the implosion design. The first British nuclear-test explosion, in October 1952, was of a plutonium implosion-design device. Britain's first droppable bomb, code-named "Blue Danube", used about 6 kg of plutonium and had an explosive yield of more than 20 kt.

The unavoidable presence of ^{240}Pu makes the gun design impossible for weapons-grade plutonium. Plutonium-240 fissions spontaneously, and releases neutrons. In a gun device, these stray neutrons would start the chain reaction off prematurely, converting the explosion into a damp squib.

Nor is this the only difficulty plutonium presents. The silvery metal, which melts at 639·85° C, can exist in at least six different crystalline forms in the solid state (and in a seventh form at high pressures). The "delta-phase" is more ductile and easier to fabricate than the other phases, but unfortunately exists only at temperatures above 310° C. To get round this problem, bomb designers alloy plutonium with about 3·4 per cent gallium. This stabilises the delta phase of plutonium down to room temperatures so that it can be worked and rolled into shape. Even then, of the radioactivity picked up by US and British analysts suggest that the bomb did not have a uranium-238 outer blanket. Without this, the yield of the weapon is greatly reduced. Had such a casing been supplied, the bomb's power would probably have been more than 100 Mt.

Compared to the two superpowers, the nuclear armouries of Britain, France and China are puny. According to Dr John Simpson's recent book *The Independent Nuclear State*, Britain possesses about 577 nuclear warheads. Fifty of them are bombs in the megatonne range, but the main arm of the strategic deterrent is 189 Polaris warheads (each about 200 kt) and 100 40 kt Chevaline warheads. The balance is made up of tactical weapons with powers of a few kilotonnes in the possession of the RAF and the Navy. The SIPRI yearbook for 1983 quotes higher figures, of about 640 warheads, for the British stockpile. SIPRI also estimates a total of 720 warheads in the French stockpile and about 940 in the Chinese.

In the face of the arithmetic of the preceding paragraphs, how could any proposal for nuclear disarmament succeed? With nearly 50 000 warheads in existence—some of them light enough to be carried in a rucksack—how could a nuclear disarmament treaty be verified?

Surprisingly, nuclear disarmament may be easier than many people think, for the laws of physics will do some of the verification. As explained in the box, three elements are crucial to nuclear weapons: uranium, plutonium, and hydrogen. Without ^{233}U, ^{235}U, or ^{239}Pu, a fission device is impossible, and without tritium—a heavy isotope of hydrogen—to

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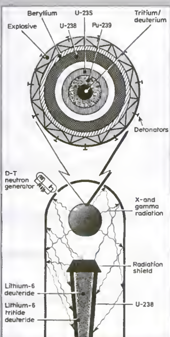
deformation by grinding can still transform a thin surface layer into a different, unacceptable phase.

Plutonium also oxidises, and to prevent an unwanted layer of plutonium oxide building up on their materials, bombmakers gold-plate their plutonium. As part of its current plans to expand its stockpile, the US government has set aside $30 million in case the price of gold goes up. (Gold-plating plutonium was one of the important technical difficulties that Britain's weapon designers had to solve for themselves after US military cooperation in atomic matters was cut off at the end of the Second World War.)

Once these problems have been mastered, however, plutonium becomes a very attractive weapons material, as it can be used to obtain a higher yield-to-weight ratio, smaller weapons size, and decreased weight. The process of enriching natural uranium into weapons-grade material has, until recently, required vast amounts of electricity. It has always been cheaper and more convenient for Britain—whose electricity is comparatively expensive—to make plutonium from ^{238}U in reactors rather than enrich natural uranium.



Modern fission weapons are made up of concentric spheres (top). The radiation can be used to trigger a fusion weapon

The implosion method of detonating a fission device offers further advantages. By bleeding a small quantity of deuterium and tritium gas into the space at the centre of the inmost hollow sphere of fissile material, designers can "boost" the bomb's yield. Under the high temperatures and pressures at the centre of the core, the deuterium and tritium will fuse. Complete fusion of 1 kg of deuterium-tritium releases about 25 times as many neutrons as the complete fission of 1 kg of uranium or plutonium. The fusion reaction does *not* contribute much to the explosive power of the bomb, and this is not the way in which hydrogen bombs are designed. The neutrons which the fusion reaction releases *fission* more of the plutonium/uranium core than would happen by an unassisted fission chain-reaction. As more fissile material is consumed, this greatly increases the energy yield of the explosion.

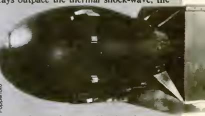
Workers at the US Los Alamos laboratory recognised the principle of boosting as early as 1945. The first really successful device used liquid deuterium and tritium. It was tested in May 1951 and yielded 45·5 kt.

Fusion weapons depend upon deuterium, an isotope of hydrogen with an extra neutron in the nucleus, and tritium, which has two extra neutrons. There are three possible reactions: D+D; D+T; and T+T. The most relevant to nuclear weapons design is the D+T reaction, for it proceeds more rapidly at realisable temperatures than the other two. One fusion releases about 17·6 MeV of energy, compared to the 200 MeV released from the fission of one nucleus of uranium or plutonium. However, because the atoms involved in fusion are so light, between three and four times as much energy is released per unit weight in fusion as in fission.

In Britain, tritium is made by the irradiation of lithium capsules in the Chapelcross reactors. Work on the tritium extraction plant—expected to cost up to £10 million—started in 1980. Before then, Britain swapped its plutonium for tritium from the US.

If fusion is to happen, then the tritium-deuterium mixture must be simultaneously compressed and heated to about 100 million °C. The only way of achieving these conditions simultaneously is by using a fission bomb as the detonator of the fusion explosion.

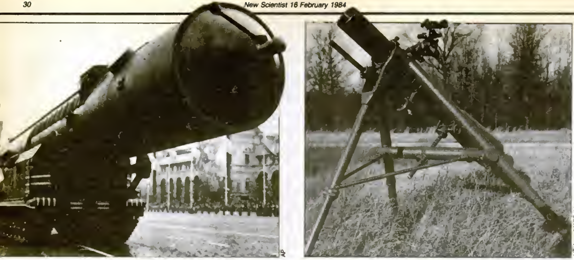
Thermonuclear weapons are axial devices; not concentric spheres like fission bombs. The detonator—a small fission device—is placed at one end, slightly off the focus of a parabolic mirror. When it explodes, it emits huge quantities of gamma-rays some of which, travelling at the speed of light, bounce off the mirror and are deflected onto the carrot-shaped pencil of thermonuclear fuel. The gamma-rays outpace the thermal shock-wave, the debris, and even the neutrons of the fission explosion. They exert a tremendous radiation pressure on the thermonuclear fuel, simultaneously heating and compressing it. It is this trick of bouncing the gamma-rays off the inside of the weapon's casing before the rest of the fission explosion has had time to blow the casing apart, that makes the thermonuclear bomb possible.


Popperfoto

Nagasaki was devastated by this plutonium bomb which weighed more than 4 tonnes and yielded about 22 kt explosive power

Fusion bombs have a further refinement: they make their own fuel! Tritium is radioactive, and about 5·5 per cent decays away into helium each year. Only a small quantity is included in a warhead to start the fusion process off. As mentioned, the fusion of tritium with deuterium produces lots of neutrons, and these can be used to breed tritium from an isotope of lithium, lithium-6. The principal thermonuclear material is usually lithium deuteride which, unlike deuterium or tritium, is a solid at room temperatures. Under neutron irradiation this handily provides both parts of the thermonuclear fuel.

There is a third element to thermonuclear weapons. They are blanketed in a layer of ^{238}U. This mops up the excess neutrons produced by the fusion reaction and adds considerably to the destructive power of the weapon. □



AP

US Army/MARS, Lincs

Little and large: nuclear weapons can be carried by missiles or launched by small mortars

"boost" the yield, most modern fission warheads would be very inefficient explosives. Weapons designers also use tritium (together with deuterium, another heavy isotope of hydrogen) in the "neutron gun" which initiates the chain reaction in a fission warhead, and to start the fusion process in a thermonuclear warhead. Of the four crucial isotopes, only one—uranium-235—occurs naturally in the Earth's crust. The others have to be "bred" in a nuclear reactor.

There are surprisingly few reactors in the world whose purpose is to produce tritium and weapons-grade plutonium. In the United States until recently, there were only three defence production reactors producing material for nuclear weapons, located at the Savannah River Plant near Aiken, South Carolina. Associated with those reactors are three plants for reprocessing their spent fuel to recover the weapons-grade plutonium and a plant to recover tritium from rods of lithium irradiated in the reactors. The US government intends to increase its stockpile to over 32 000 nuclear warheads by 1990 and, to meet the consequent increased demand for fissile material, it has restarted a fourth reactor at Savannah River. The US has another facility for producing weapons-grade material at Hanford in Washington State.

In the 1950s, Britain built two sets of reactors to produce weapons-grade plutonium; four reactors at Calder Hall, next to Windscale; and four at Chapelcross, on the Solway Firth in the south of Scotland. Up to 1964, these plants (and earlier ones on the Windscale site) produced 2·7 tonnes of weapons-grade plutonium for Britain's nuclear weapons. In 1980, work started on a £10 million plant for producing tritium at Chapelcross.

France's weapons-grade material production is concentrated at Marcoule in the Rhône valley. Plutonium is produced in gas-graphite reactors whose fuel is reprocessed at Marcoule, and two heavy-water moderated reactors—named Celestin—produce tritium by irradiating lithium. According to the London-based Aviation Studies Atlantic, the People's Republic of China produces its plutonium at two reactors near Paotow, and also at a plant near the Tarun River in Sinkiang province. It seems likely that the Soviet Union has a similarly highly concentrated complex for the production of the tritium and ^{239}Pu necessary for its nuclear weapons.

Because so few reactors are involved in producing weapons-grade plutonium, and because they all ultimately depend upon supplies of uranium, it might at first sight appear that controlling the supply and destiny of uranium is the key to controlling, if not reducing, the production of

The vision that failed

Popperfoto

J ROBERT OPPENHEIMER (left), the driving force behind the US wartime effort to build the atomic bomb, and David Lilienthal, first president of the US Atomic Energy Commission, drew up the first plans for comprehensive abolition of nuclear weapons. They proposed that a United Nations Atomic Authority should be set up which would own all the uranium and plutonium in the world, all nuclear reactors, and to which the US would surrender its nuclear weapons and designs, thus making the UN the sole repository of information on nuclear weapons technology. The plan which the US finally presented to the UN in 1946 was much altered from the Oppenheimer and Lilienthal original, but it is unlikely that, with Stalin in the Kremlin, any plan would have succeeded. Despite the failure of the 1946 plan for disarmament, both men later opposd the hydrogen bomb project, arguing that it would trigger an unending arms race

Photos by National Atomic Museum

Nearly 40 years of the technology of nuclear weapons on display at the National Atomic Museum, in Albuquerque, New Mexico, USA

nuclear arms. President Eisenhower suggested just such a move in March 1956 to the Soviet premier Bulganin "so that future production of fissionable materials anywhere in the world would no longer be used to increase the stockpiles of explosive weapons". Unfortunately, he also assumed "the satisfactory operation of our air and ground inspection systems", and this intrusive verification procedure was unacceptable to the Soviet Union.

Although no formal treaty emerged, Britain, the US and the USSR agreed in 1964 that each would unilaterally reduce its production of weapons-grade uranium and plutonium. The gesture was somewhat hollow, as each nation by then judged it had stockpiled enough nuclear material to serve its military needs. By the mid-1960s, weapons designers had started to move away from the multi-megatonne blockbusters of the late 1950s to smaller, more accurate warheads. They got the fissile material for these new weapons by recycling the uranium and plutonium from older warheads that had been retired as obsolete.

Arsenal halved in a decade

The 1964 reductions, however, did not include tritium, because continued production of this isotope is necessary to maintain the effectiveness of nuclear weapons. Tritium is radioactive, and has the comparatively short half-life of 12·33 years. This means that about 5.5 per cent of the tritium in nuclear weapons decays into helium every year. The designers of nuclear weapons originally thought that the decay of tritium would not affect the performance of their weapons significantly. By the early 1970s, they had changed their minds. According to *The Independent Nuclear State*, Britain conducted an underground test in Nevada in 1974 to see how much the effectiveness of an old warhead had decreased due to the problem of ageing tritium. And, in an internal report in August 1981, A. T. Peaslee, a staff member of the Los Alamos Laboratory which designs new warheads for the US arsenal, noted that "a cutoff of special nuclear materials production [that is, including tritium] at the defence production reactors would mean the certain disablement, in approximately a decade, of one half of the nuclear weapons stockpile that uses tritium." What Peaslee did not mention was that all the strategic and most of the tactical nuclear weapons in the US stockpile use tritium.

The problem of verifying that a country is dismantling its nuclear weapons under a disarmament treaty therefore reduces—at least in principle—to verifying that no tritium is produced for military purposes. Can this be done?

Producing tritium for nuclear weapons is not simple. It is costing Britain about £10 million to build a tritium-producing plant at Chapelcross. Details of this are secret, but the French have published information on how they make tritium, and the process is broadly similar. Tritium and helium are made when a neutron hits a nucleus of lithium-6. About 35 per cent of the lithium occurring naturally is lithium-6. The French irradiate rods highly enriched in this isotope. This is done in reactors moderated with heavy water and fuelled by natural uranium. (Chapelcross's reactors also

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use natural uranium as fuel, but have graphite as the moderator.) The lithium rods are then processed to extract the tritium. Because it is both radioactive and chemically identical to hydrogen, tritium is biologically hazardous: it is very easy for people to ingest tritiated water, should tritium escape into the biosphere. For this reason, the complex process of tritium extraction and purification has to be performed by remote control in large concrete-shielded cells. The French extraction plant occupies 5000 m^2 and its air-conditioning plant delivers 140 000 m^3/h of fresh air.

It is unlikely that inspectors verifying an arms control agreement would miss the facilities for enriching lithium, the cans of lithium rods being irradiated in the reactor, or the large tritium extraction plant. Moreover, if they are monitoring the spent fuel from the reactor, they would notice some discrepancies. To produce 1 kg of tritium, the irradiated lithium will mop up neutrons that otherwise would have produced 72 kg of plutonium in the spent fuel.

In this way, a nuclear disarmament treaty could—in principle—be verified without inspectors ever entering a nuclear weapons plant, without counting a warhead, or trying to assess how much fissile material a country has in its stockpile. The radioactive decay of tritium would do most of their job for them. Inspectors would still need to visit hitherto secret defence production reactors, however, and given the Soviet Union's historical opposition to on-site inspection, is there any possibility that it would ever permit inspectors near its reactors?

Soviet change of heart?

The USSR's attitude does seem to be changing. Last year, it started negotiations with the Vienna-based International Atomic Energy Agency (IAEA) to allow the Agency's staff to inspect some of its (civilian) nuclear reactors. The IAEA has been developing its system of international nuclear safeguards to check that nuclear material in civilian hands is not diverted to the making of bombs. At present, the system—designed to prevent the further spread of nuclear weapons—is applied only on a voluntary basis to those countries which already have the Bomb, but it does cover 99 per cent of all nuclear installations in the world outside the nuclear weapons states.

In the IAEA, the world already has an institution that could serve as a model for verification of arms control and disarmament agreements. The Agency's expertise is limited to the civilian nuclear fuel cycle: it is only beginning to gain expertise in safeguarding heavy water (which contains deuterium), and it has no experience of safeguarding tritium. But it does have nearly 20 years' experience of the bookkeeping and inspections necessary to follow fissile material through the fuel cycle. Although the nuclear weapon states would probably be reluctant to entrust the IAEA itself with verifying nuclear disarmament, the nuclear field is the only area of weapons technology where some of the problems of verification have been worked out.

Peter Kennard

However, it would still be possible for the nuclear weapons states to recycle their weapons-grade plutonium and uranium. Since both plutonium and uranium have half-lives measured in thousands of years, it might seem that stockpiles of these weapons would be long-lasting.

In fact, plutonium also needs constant care and attention. The ^{241}Pu, which is inevitably produced along with ^{239}Pu and ^{240}Pu, decays with a half-life of only 15 years into americium. This element is itself radioactive and causes the plutonium-americium mixture to heat up. Having hot, expanding metal at the centre of the complex, precisely engineered system, would damage a nuclear weapon. So each warhead's plutonium fissile core has periodically to be removed, reprocessed and reworked. In Britain, this work is done at a small plant at Windscale. In the United States it is done at the Rocky Flats nuclear weapons plant near Denver, Colorado.

Americium presents a big problem to the weapons' designer. In 1964, more than 5 kg of americium was recovered from used plutonium warheads in the US. Since 10 g of ^{241}Pu yields about 4 g of americium, this suggests that the Rocky Flats plant was then reworking about a tonne of old warheads each year.

There are other problems. Part of the US stockpile of weapons-grade plutonium is unusable. Testifying before a US Congressional Subcommittee in June 1980, Mr Duane Sewell, Assistant Secretary for Defense Programmes, admitted that the material "needs to have certain contaminant materials taken out of it. Americium is one that grows in as the material ages, and another is gallium, which is one of the stabilising elements that we put in. There is a considerable amount of material that is not directly usable."

Even if, in some political convulsion, the world's nuclear weapon states agreed to ban the production of tritium for military purposes, and further prohibited the reworking of plutonium, they would probably still be left with ^{235}U weapons. But although such a warhead can still be devastatingly powerful, it would have to be much bulkier and heavier than the current generation of weapons. The extra weight comes not so much from the increased amount of uranium required to raise the yield of a pure fission weapon, as from the quantity of chemical high explosives needed to compress the massive fissile core to a supercritical density.

With such bulky nuclear explosives, many of the delivery systems would lose their *raison d'être*. A high-yield, pure-fission ^{235}U warhead could not be carried on a cruise missile. The masterpieces of miniaturisation represented by Chevaline and the multiple warheads on top of Poseidon missiles would be impossible. A tritium cutoff would also ease the missile-counting disputes that have so plagued strategic arms talks. □

Science and government—debate without an end

Government and Research
by Maurice Kogan and Mary Henkel, *Heinemann, pp 196, £18·50*
Priorities in Research
edited by J. Kendrew and J. Shelley, *Elsevier, pp 191, 140 guilders*

Fred Dainton

C. P. Snow saw that the worlds of science and government must meet

Cavendish Laboratory, Cambridge

THE FAME of C. P. Snow as a novelist seems to rest less on his prose style, the originality of his plots or his insights into the human condition than on the fact that he is a wholly credible chronicler of a particular sector of 20th century British middle class society with its poles in London and Cambridge. I often feel that there was another, an inner, polarisation derived from his personal history. His work as a physical chemist, primarily a spectroscopist, in Free School Lane made him deeply aware of the motivations of the other scientific denizens of the New Museums cluster of laboratories in Cambridge.

Yet he was conscious that the better world which science could make possible would never come about without the necessary political will and an appropriate government machinery; a view which must have been strengthened by his move to London and his work for the Register of Scientific and Technological Manpower, for the Civil Service Commission, and during his brief ministerial office. His concern with the central issue was expressed in a modest, rhetorical question which he posed at the beginning of the penultimate chapter of his Godkin lectures delivered just 23 years ago in Harvard. "Is there any way, in this great underground domain of science and government, in which we can arrange to make choices a little more reasonably?" he asked.

Each of the two books under review addresses, either explicitly or implicitly, this question, but they too are poles apart. One carries the general title *Government and Research* but is a close scrutiny of a particular episode which briefly (for nine years) perturbed the British government's funding of medical research. The other book has the title *Priorities in Research*, which suggests particularities but is in fact the rather rambling discussions of about 20 people, the majority of whom are scientists, concerning papers which eight of their number presented when they were all gathered at Kronberg im Taunus, Germany, to participate in the somewhat grandly styled "Fourth Boehringer Ingelheim Symposium".

The first book, by the professor and a lecturer in the Department of Government at Brunel University, is based on an empirical study by them, and in its earlier stages also by Nancy Korman, of the management of research in the Department of Health and Social Security (DHSS) which came under the aegis of the Chief Scientist's Office.

It is unusual in that the researchers had access to all papers and sat in as observers at many meetings. They were able to see at first hand the operation of research management, the process of peer review of five DHSS research groups and to talk freely with the dramatis personae. Thereby they gained insights into the roles and the informal and formal structural relationships of the people involved. To someone like myself, who was consulted by the DHSS about the form the Chief Scientist Organisation should take in that department following the transfer of money from the Medical Research Council to the department, the result makes fascinating reading though marred by some irritating and unnecessary slips.

There are several interesting conclusions, some of which (for example, that the customer-contractor relationship is a simplistic metaphor) could be seen to be valid without the necessity of research; others on the nature of negotiable interactions between science and government, the pros and cons of imperative planning of research, are more subtle and revealing.

Government and Research is welcome evidence of at least one department's willingness to let a small chink of light shine on its workings. It should be useful background reading for civil servants and scientists alike who have to interact over the business of research for which the government pays; though, paradoxically, I suspect that the very constraints on public expenditure which intensified the need for a better understanding between them is creating so many daily pressures and problems that few will have the time to peruse this book and ponder the issues which it raises.

Priorities in Research is at the other end of the spectrum. It has no conscious empirical research basis and it seems to lack coherence because the objectives are unclear, so that it ranges from historical perspectives of what has happened, through the problem of choices within science, to the reasons and mechanisms for undertaking scientific research paid for by governments and industry. Since many of the participants at Kronberg had prominent roles in mediating the science-government interface it is, however, arguable that, if not research-based, the contributions are at least founded on experience of having to deal with the "real" questions of how much money to put into this or that scientific enterprise. This gives a certain interest to the reader as the invisible voyeur of a coterie in action.

I have enjoyed reading these books. I recognise that this, because of my own experience over almost 25 years, may be a minority taste. Many who pick up these books will be looking for some neat package of principles which are a reliable guide to policy formulation and the creation of structures to implement it. They will be disappointed and, as I reflect on the history of the involvement of successive British governments in science, I am no longer surprised. First, taking us to the end of the 19th century, there were the prizes offered by the Board of Longitude in 1714, through Sir Humphrey Davy's and Charles Babbage's concerns over the application of science, to the activities of Colonel Strange and the Devonshire Commission impressing the need for a national science policy. Secondly, this century has seen the struggles towards a policy, with the advocacy of Lord Haldane and Christopher Addison for research councils, the reorganisation of these and of science in government departments which took place with the 1965 Science and Technology Act and the proliferation of structures expressed in acronyms such as ACSP, CSP, ABRC, ACARD, CPRS, and so on.

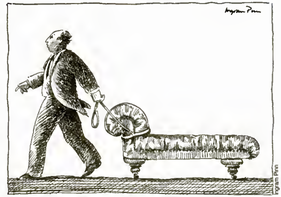
The facts are that science is largely autonomous in direction and largely unpredictable in many of its findings and their impact on human societies, but is so expensive that government must be the major paymaster. It must therefore be firmly and irreversibly embedded in the government machine but it is highly unlikely that the precise organisational form for its administration will forever remain as it is now. Scientific advances will always create new problems and opportunities which no one can foresee, and therefore one can predict a repetition of the sequence: recognition of the problem or opportunity, taking *ad hoc* measures to deal with it, reconsideration in the light of some years experience leading to a reorganisation of structure.

Perhaps this sequence is the only immutable, evolutionary principle; a conclusion which may go part of the way to answering Snow's question. □

Properties of pets

New Perspectives on Our Lives With Companion Animals
edited by Aaron Katcher and Alan Beck
Pennsylvania UP, pp 588, £18·75

Dennis Lendrem



IN 1961 Boris Levinson delivered a paper to the American Psychological Association on the potential role of dogs in psychotherapy. The paper, "The dog as co-therapist", marks the emergence of a new field of research—the study of people and their pets. At the time, the paper was given a lukewarm reception, and Levinson was ridiculed by some colleagues—did the dog share his fees?

Twenty years later, the dog's co-therapist found himself addressing a packed hall on his vision of the future of research into the relationship between people and their animal companions. The occasion was the International Conference on the Human-Companion Animal Bond held at the University of Pennsylvania. This volume is the published proceedings of that conference.

There was too much advocacy in the air for the editors to pretend that people attended the conference just to present and evaluate data on people and their pets. The 50 or so chapters provide plenty of material to justify pet-ownership in the face of increasing economic and social restrictions (such as the so-called "scoop laws" introduced in the US). But there are also chapters on animals as socialising agents for chronic psychiatric patients, animals as facilitators of speech in normal and disturbed nursery-school children, the placement of pets with the elderly, and the influence of pets on their owners' health (see *New Scientist*, 13 October 1983, p 80).

Did you know that pets are social lubricants? Take a simple activity like a walk in the park. If you take your dog you are twice as likely to find people stopping to talk to you. What is more, they will talk for longer than if you are on your own. The scruffiest of mongrels can also enhance your social esteem. Strangers are more likely to see you as a warm, generous and intelligent human being if you are seen with an animal than if you are alone.

Some contributors have advice to offer the bereaved pet owner, and on the problems of having a social predator as a pet (dogs, for example, do occasionally kill and eat people!). Finally there is a more philosophical section that covers pets and morality and looks at pet-ownership from the perspective of animal welfare. All told, there is sufficient "exuberant variety" to interest ethologists, psychologists, sociologists, veterinarians and social workers alike.

The editors have skilfully pruned the text of redundant discussion and repetition, and excised sections justifying an interest in pets. Sadly, even this does not hide the mediocrity of many papers, even less those that are downright sloppy. Yet authors complain that establishment science does not accept their methods. This is hardly surprising when those methods are founded on personal reminiscence and an appeal to poetic sensibility. If you will write semi-mystical rubbish you can hardly expect a hearty slap on the back from the scientific community. But one or two authors show that it is possible to make a structured study of the woollier side of the human-companion animal bond; Robert van de Castle's "Animal figures in fantasy and dreams" makes fascinating reading.

It is clear that a solid framework is emerging for the study of pets and their owners. It is, as the better papers show, a fascinating area and should enjoy further growth (and funding) in the years to come. ☐

Worries of a dominant primate

Ethics and Animals
edited by H. Miller and W. Williams, *Humana/Wiley, pp373, £37*

Mary Midgley

CLOSE observers of *Homo sapiens* have long reported that the species, despite its name, actually finds thinking quite hard, and that by far its strongest motivation comes from habit. So it is no great surprise if its members, brought up in a culture which has systematically avoided thinking about its relations with other species, have difficulty in breaking that habit even when their own interests call for it quite loudly. In trying to break it, they tend to get entangled in their own web of other habits, and in particular to beat helplessly against the confines of their own intellectual disciplines.

Getting free takes time and cooperation, during which each party needs to restrain its irritation at the strange limitations of its colleagues. This process is going on in the papers—mostly but not all philosophical—collected in this thick American volume, *Ethics and Animals*.

Does it matter how we treat animals? And if so why? A good part of the book—too much for some readers—is occupied by philosophers agonising about how, and how far, to say that it does matter, without finally smashing a framework of thought which claimed that it didn't. We are outgrowing that framework—which was not just an academic one—partly because of dangers to the biosphere, partly from concern about suffering, but perhaps centrally because a Darwinian sense of our continuity with other creatures shakes the doctrines which used to guarantee a total right of exploitation. Immortal souls are now rather out of fashion.

Rationality—the best remaining pedestal—remains, but we find it less clear than our forebears why a right of exploitation should follow from it. The most plausible reason is that all morality consists of rights derived from a kind of social contract—a club to which only rational humans can belong, so that everything else is excluded by definition.

The simplicity of this idea is paid for by a great many implausible features—notably that it seems to exclude irrational humans, such as babies, and that it ignores the whole range of motives involved in morality except for calculating self-interest. Much of the discussion here is concerned with putting back these and other jettisoned elements in the concept of morality.

In general, there is a very strong tendency today to think of morality chiefly in terms of competing rights, and not to look for any source of those rights other than self-interest, conceived as expressed in a kind of contract. The effect is to leave the chaos of conflicting rights undiscussable, and so to endorse the tendency to settle such conflicts by blows. Against this background, it was inevitable that those championing animals should phrase their defence in terms of "animal rights", and that a sterile battle over the possibility of these rights should follow instead of a clearer discussion of what such terms as "rights" mean and commit us to.

The battle is still being waged in this book. But much of the discussion goes beyond it and raises some vast and serious issues. Much more work is needed from all sides. But there is certainly some progress here. ☐

This week's contributors

Sir Frederick Dainton FRS is chancellor of Sheffield University and a member of the Council for Scientific Policy.

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Richard Peto is reader in cancer studies at the University of Oxford and co-author with Sir Richard Doll of *The Causes of Cancer* (Oxford UP).

Roger Short FRS was director of the MRC Reproductive Biology Unit at Edinburgh, and is now professor of physiology at Monash University, Australia.

High or low technology in family planning?

Birth Control Technologies—Prospects by the Year 2000
by M. J. K. Harper, *Heinemann Medical, pp 271, £15*

Roger Short

MICHAEL HARPER is an English biologist working in the Department of Obstetrics at the University of Texas in San Antonio. Having previously served for a number of years on the staff of the World Health Organisation's Special Programme of Research Development and Research Training in Human Reproduction, he is well placed to describe the cafeteria of family planning methods that may be available for our choosing by the year 2000. But in a sense he did not select the topics for discussion in this book; they were arrived at by what is known as a Delphi survey.

Questionnaires were addressed to 36 individuals knowledgeable in the field, seeking their views about the order of priority they would assign to potential new and improved birth control techniques of global significance that might become available by AD 2000. Of the 36 named individuals who were approached, only 23 bothered to reply.

Although we are not told who they were, it is worth considering for the moment the make-up of this polyglot Delphic oracle. Twenty-six individuals came from the US and two from UK; only three were from developing countries, two being from Mexico and one from India!

So this book is inevitably an American high-technology view of what the overdeveloped world would like to be able to use as contraceptives in the year 2000, regardless of expense; as such, it is an excellent summary of the scene. However, this may bear little resemblance to what the developing world will be able to afford to use by the turn of the century.

In 1981 the world population was estimated to be 4·492 billion, a figure that is expected to exceed 6 billion in the next 16 years. Most of this increase will occur in the populous and poverty-stricken nations of Asia. About one individual in five in the world today is Chinese, and we must watch with bated breath China's imaginative attempts to control her numbers by motivating her peoples to use simple present-day family planning techniques. If she fails, what chance is there of any other developing country succeeding?

Another statistic that we must always keep in mind is that only 17 per cent of couples in developing countries today are using modern forms of contraception, and in poorer countries such as Bangladesh the figure is below 10 per cent. Surely our first priority, therefore, must be to concentrate on the implementation of family planning programmes using the contraceptives we already have, and sweeping away illogical political constraints that hinder their deployment?

A finger of blame can be pointed at the developed countries in this regard. The political dithering that continues to surround the injectable gestagen Depo-Provera is a good case in point.

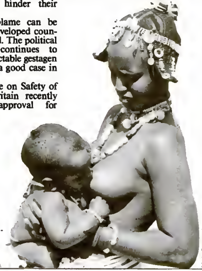
The Committee on Safety of Medicines in Britain recently recommended approval for Depo-Provera as a contraceptive, but its advice was overruled by the minister. In the United States, we still await a judgment on Depo-Provera from the Food and Drug Administration, and until it is approved as a contraceptive in the United States, it cannot be used in family planning programmes around the world that are funded by the United States Agency for International Development, the principal funding agency in this field. Depo-Provera, and a family of newer injectable and implanted gestagens that are under development, have a major role to play in developing countries because they do not depress milk yield and hence can be safely used by lactating mothers. The potential good they do to mother and child by encouraging breastfeeding and prolonging the the birth interval far outweighs the theoretical risks, which have yet to be substantiated by any clinical evidence.

Those of us involved in research in family planning entered the 1970s full of hope. Provided that sufficient funds were made available, it seemed certain that the scientific method would lead to the development of radically new forms of contraception that would meet everybody's needs. In the event, the task has proved far harder than any of us had anticipated, and Dr Harper's book outlines many of the reasons why.

The time has therefore come for a radical reassessment of the situation. Can we still afford to fiddle with the development of new methods while Asia burns? We must take urgent steps to ensure that the contraceptives we already have are put to full use.

Nor should we forget Nature's contraceptive. Breastfeeding still prevents more pregnancies in developing countries than any other form of contraception. Although a consultant to one of the powdered milk companies recently suggested that it was a cruel and potentially damaging form of contraception (*British Medical Journal*, vol 284, p 1725, 1982), developing countries such as the Philippines could undoubtedly lower their rates of population growth and improve infant health if they were to follow the example of Papua New Guinea and make feeding bottles and powdered milk available only on medical prescription.

How can we get such simple messages across in a world that worships high technology? The fact that I was one of the 23 knowledgeable individuals who replied to Harper's questionnaire, and yet breastfeeding receives not a mention in the entire book, highlights the dilemma. □



Nature's contraceptive: "Breastfeeding prevents more pregnancies in developing countries than any other form of contraception". In developing countries, less than 20 per cent of couples use modern forms of contraceptives

Marie Stopes/Christine Osborne

When in doubt, invent

TELEVISION

Bernard Dixon

WATCHING faction can be a disorienting experience. As drama documentaries like *Oppenheimer* have shown, this hybrid brand of communication gives televisual science unique dimensions of vitality. Measured against that merit, however, is an inevitable greyness in verisimilitude. When writers pick and choose from the record, freely inventing that which is not on the record, they leave inquisitive viewers with uneasy doubts about the admixture of history and invention.

The Garden of Inheritance (BBC2, 6 February) illustrated the problem beautifully. Here was a competent, colourful (and very expensively filmed?) account of the dawn of modern genetics, the story of Gregor Mendel. But what of the social intercourse inside his Augustinian monastery? What of his friends, family, and links with the Brno Natural History Society, where he presented his revolutionary findings in 1865? Trying to answer such questions, while dealing with someone whose life is arguably less well documented than that of any other major figure in world science, dramatist Elaine Morgan must have faced severe difficulties.

So, just as the brain compensates for missing information in optical illusions, Elaine Morgan provided light and colour. She gave us, for example, the sinister figure of Fr Rambousek—made doubly convincing by being played by Terrence Hardiman, who always plays sinister figures. According to this account, Rambousek was a persistent pest, sneaking on Mendel, putting forbidden books out of reach in the library, and ensuring that the great man's experimental notes went on to a bonfire after his death. Now, as we know from scholarly works such as Hugo Iltis's *The Life of Mendel*, Rambousek undoubtedly existed. He had been a fellow novice, and ▸

▸ eventually succeeded Mendel as prelate. But did he actually behave as dreadfully as this? Or has Elaine Morgan exercised discretion to create theatrical tension where none existed? I feel that we should be told.

Clearly, *some* invention is unavoidable in a programme of this nature. So one would certainly not quibble over incidents such as an alleged conversation between Mendel and his mentor Johann Nave in the Vienna Woods in 1853. As television, the importance of this scene lay in its vivid explanation of particulate inheritance in terms that were crystallising within Mendel's cerebal cortex at the time. It hardly matters whether he really did move so eloquently from miscible liquids to a chemical analogy with mixtures instead of compounds, and hence to beads on his rosary. As pure instruction, the dialogue was excellent.

But major elements in a story line are a different matter. Here *The Garden of Inheritance* was conspicuous in virtually ignoring one aspect of Mendel's research which certainly has been reassessed in the light of modern knowledge. For whatever reason, Elaine Morgan chose to set aside the work of R. A. Fisher and others who have demonstrated beyond cavil that those original ratios were too good to be true.

Speculation has it that an overzealous assistant, rather than the god-fearing monk himself, must have tidied up the figures. Yet apart from just two sentences exchanged during an episode of wrinkled and round pea counting ("Which would you like them to be?" "That is not at all a proper question"), the dramatic potential of this timely angle was overlooked in the film.

With these caveats (and despite scraps of conversation resembling Min. of Ag. pedagogy inserted into *The Archers*), this was an agreeable programme. It succeeded particularly well in portraying the sheer volume of effort required to establish Mendelian ratios. Above all there was a final sense of greatness unrecognised, after years of tension between innovation and authority. "Perhaps that is what I should have been aiming at all along, cultivating piety instead of peas," Elaine Morgan's Mendel said towards the end.

That is one factional sentence, made more poignant by our awareness of the momentous rediscovery of Mendelism 16 years later, in 1900, to which I do not object. □

Cancer on the body politic

Atlas of Cancer Mortality in England and Wales
by M. J. Gardner, P. D. Winter, C. P. Taylor and E. D. Acheson, *Wiley, pp 116 including 69 colour maps, £45 (£35 until 1 March)*

Richard Peto

IT WAS realised, during the 1950s, that smoking was an avoidable cause of the majority of cases of cancer of the mouth, throat and lung in Britain, and at present smoking is a cause of about one-third of all British cancer deaths. This proportion is 10 times as large as that due to alcohol, which, at 3 per cent, is the next largest reliably known cause of British cancer deaths. Indeed, it is considerably larger than the sum of all other reliably known effects put together. Thus, present knowledge can offer the means to prevent barely 40 per cent of British cancer deaths, so the evidence that most of the remaining deaths are also in principle—if not yet in practice—avoidable has to come from indirect arguments.

By far the most powerful of these has been comparison of tissue-specific cancer rates in Britain with those in other countries, and to this Martin Gardner and his colleagues from Southampton University have now added the convenient, visually attractive comparison of cancer rates in different parts of Britain with each other.

Of course, the differences in life style etc, between Lancashire, Wales and Sussex are much less extreme than the differences in life style between Britain, Japan and Nigeria, and so the differences in the onset rates of particular cancers are also less extreme. For example, whereas the death rates in Britain from cancer of the large intestine are an order of magnitude larger than those in Japan or Nigeria (suggesting that more than 80 per cent of British deaths from this disease could have been avoided by suitable dietary or other habits), the death rates from stomach cancer in Wales and the industrial areas of the Midlands and Northeast are only about double those in the Southeast of Britain—see Figure 1.

Superficially, the study of such twofold differences within one country is less attractive than the study of tenfold differences between countries. This, however, is counterbalanced by the greater comparability of procedures by which cases are diagnosed and counted in different parts of one country, and by the fact that people in Britain have so much in common with each other that some of the key differences in life style within Britain may be easier to spot than when two utterly different countries are compared. Moreover, in the decades that have already elapsed since attention was first drawn to the large international differences in cancers of the stomach, large intestine, breast etc, none of the really important causes has been reliably identified; so, any new evidence that might be useful is to be welcomed.

Unfortunately, it is still not clear how useful such maps will in practice be. The US cancer atlas, by which this British atlas was in part inspired, has been available for years, but correlational studies based on it do not as yet appear to have borne much fruit. (Perhaps the recent Chinese cancer atlas will prove to be of greater value, simply because the differences between Chinese counties are so much larger than those between British or American counties.)

There are several sources of difficulty in trying to make use of such atlases.

First, there is, as always in epidemiology, the problem of confounding. For example, lung cancer death rates are significantly high in many cities (see Figure 2). Before any inferences whatever can be drawn about the relevance of air pollution, however, one must make due allowance for the delayed effects of any urban/rural differences in the smoking habits of young men half a century earlier (*The Causes of Cancer*, Oxford UP 1981, Appendix E). Unfortunately, this is simply not possible.

Secondly, there is a lack of data on potential correlates of the rates of onset of disease: data are needed on past and/or present smoking, drinking, working, eating and reproductive habits, on the composition of air, water (both hardness and pollutants) and soil, on population density, income, divorce, industry, sunshine etc.

Sunshine, for example, would be particularly interesting for skin cancer. Death rates from melanoma, which is a malignant neoplasm of the melanin-producing cells of the skin, exhibit a beautiful gradient from the North to the semi-sunny South (see Figure 3) which would appear reassuringly easy to understand, but for the fact that death certification rates from non-melanoma skin cancers (see Figure 4) exhibit the opposite tendency!

In failing to provide any data on possible correlates, the *Atlas* is seriously at fault; some such data should surely have been added, for otherwise the pictures are almost meaningless, especially to readers in other countries.

Next, there is the perennial problem of how to represent simultaneously both the scale and the statistical significance of any apparent differences. If some areas have large enough populations for statistical stability and others have small populations and hence statistically unstable rates, then many of the apparent high and low rates will be bogus, and much of the informative scatter of rates among the large populations will be lost. (One can merge any areas with populations below a certain limit with adjacent areas, but no ideal solution to the problem exists.) One approach that should be much more widely tried in these circumstances is "James-Stein" estimators (*Scientific American*, vol 239, p 119), which move each of the separate rates towards the national average by factors that depend on their variances. James-Stein estimators are one of the few parts of simple statistics that are sufficiently counter-intuitive to be beautiful, and they are ideally suited to disease mapping.

Finally, some odds and ends. It would have been nice to have truncated the calculations for age standardisation at 64 (or at most 74) years of age, since the data at ages 75+ are so unreliable. It would have been nice to have had data for lung cancer in middle and old age mapped separately, to see whether the urban/rural gradient was as marked in early middle age as it is in old age. It would have been nice to have had county-specific maps for each site (including those that had already been mapped in more detail); to have had a transparency with the counties and main towns marked on it that could be overlaid onto the maps to help orientate oneself, and so on. But, the book already costs £45 without such extras!

More importantly, a list of minor complaints does not do justice to the major effort that has gone into this atlas by Dr Gardner, by his colleagues in Southampton, and by the unsung heroes at the Office of Population Censuses and Surveys. This atlas is a first-rate achievement, from which many readers will derive both pleasure and knowledge. □

THE MAPS from the *Cancer Atlas* show the enormous variation in death rates from cancers in different parts of Britain. But, as Richard Peto describes opposite, we must take many factors into account before we can conclude too much from them—as to the influence, for example, of living in the town or the country, or living in the north as opposed to the south

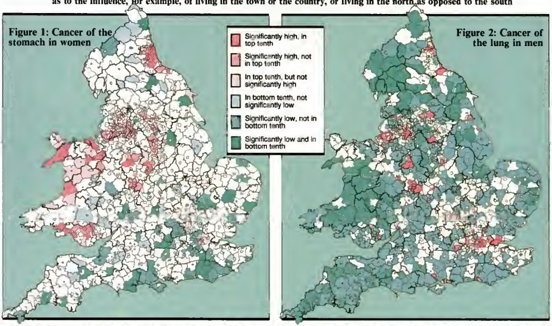


Figure 1: Cancer of the stomach in women

Figure 2: Cancer of the lung in men

Significantly high, in top tenth
Significantly high, not in top tenth
In top tenth, but not significantly high
In bottom tenth, not significantly low
Significantly low, not in bottom tenth
Significantly low and in bottom tenth

The maps above are divided into local authority areas. In the areas shown in shades of red, the mortality rate from such cancer is higher than the national average. In those marked in dark red and in mid-pink, the increase is statistically significant; and in the dark red is so high as to be in the top tenth for the country. Pale pink areas have a very high rate—in the top tenth—but numbers are too small to be statistically significant. The areas marked in shades of green are those with a correspondingly low rate

On the maps below, broken down by county, the two shades of orange represent a higher rate of death from cancer, and the two shades of blue a lower rate, than the national average

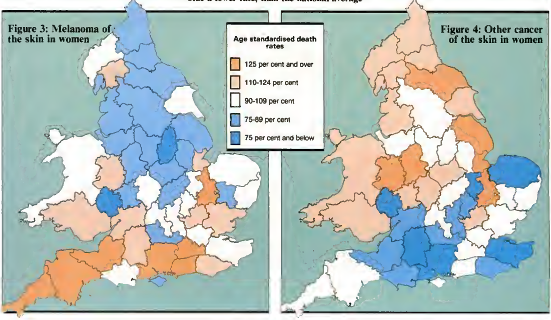


Figure 3: Melanoma of the skin in women

Figure 4: Other cancer of the skin in women

An everyday story of countryfolk.
3
1
2
4

1. Since the village bus service was axed, young Jack Norris has had to leave his home and friends in order to live nearer his job, 12 miles away. It's a shame the way the old place keeps losing so many of its young people.

2. The village bus service was so handy for Mrs. Payne. It meant that whatever she couldn't buy in the village, she could always get in the next town. Now there's no bus, she's got a problem. Not to mention a 3 mile walk. Because in common with 70% of British women, Mrs. Payne does not have a driving licence.

3. Like a lot of young people today, Alan Murphy can't get a job. And now, he doesn't even have the means to go after one, because he's got no bus service either. No bus. No job. No hope. Alan is finding village life more and more frustrating…

4. Mrs. Sarah Smith (68 last birthday) used to rely on the village bus to take her to the doctor's surgery. Now the bus service has gone, she either has to beg a lift or take a six mile hike. It seems that when you live in the country, you have to be fit to be ill.

5. Ted Armitage hasn't been on a bus in years. Hasn't needed to with the car. But he's far from happy about the effect the lack of a bus service is having on the village. Ted runs the local shop – and it's not good for business the way people keep packing up and leaving. And then there's his old ma. She used to rely on the bus a lot. Now she's going to be relying an awful lot more on Ted and his car.

6. It's not little Jane Harding's fault that her new secondary school is 2½ miles away from the village. But it's her problem. Because Jane's parents can't afford to run a car and the bus that took her to school has run its last journey. Now she has to bike it. And that's not much fun in the winter.

7. Tracy Cole is 17 and she's had it with village life. There was never much to do there anyway, but now the bus service has gone, she and her mates feel marooned. Never mind what her parents say, she's off to the bright lights and the big city just as soon as her bags are packed.

These stories represent the kind of problems faced by today's countryfolk. What's to be done to help them? This was one of the topics discussed by a wide range of community interests at a recent Convention in London. We'll be pleased to send you a complimentary copy of the Convention Report in exchange for the coupon.

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We'd all miss the bus

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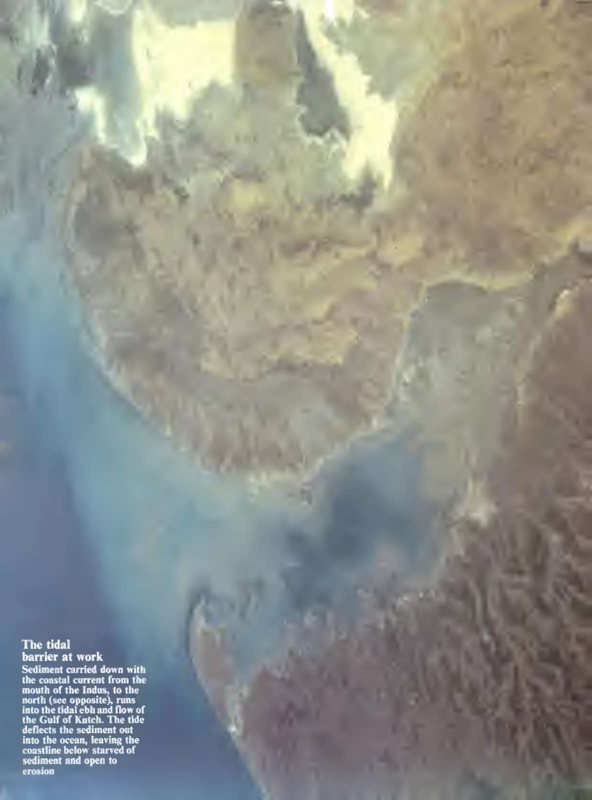


The tidal barrier at work

Sediment carried down with the coastal current from the mouth of the Indus, to the north (see opposite), runs into the tidal ebb and flow of the Gulf of Kutch. The tide deflects the sediment out into the ocean, leaving the coastline below starved of sediment and open to erosion

The Indus paradox

The success of harbours, the stability of beaches and their freedom from pollution, all depend largely on the effects of currents on the sediment discharged from rivers. One of the world's greatest rivers, the Indus, shows that our knowledge of these effects has a long way to go

R. R. Nair

THE OCEAN'S CURRENTS, like the circulation of the atmosphere, do not acknowledge national boundaries: one nation's waste is unwittingly bestowed on another. Britain recognised the advantages of monitoring waste dispersal during the Second World War when it analysed the radioactivity in the air over cities in Germany. It reached conclusions, correctly as it turned out, about the nature and extent of German research on the atomic bomb. The fall of acid rain in Scandinavia—from the sulphur dioxide emissions in the United Kingdom and elsewhere in Europe—is yet another example of inadvertent pollution of one nation by another.

Many of the principles of analysing the flow of materials in the atmosphere could be applied to waste dispersal in the oceans. During a study of the flow of sediment, especially particles of mica, in the Gulf of Kutch, in the Arabian Sea, our research team from India's National Institute of Oceanography observed abnormal variations in the distribution of sediment in the adjacent continental shelf and the Gulf of Kutch. While attempting to explain these variations we came up with the concept of "dynamic barriers".

In the story that unfolds below there are two principal "characters": the River Indus and the Gulf of Kutch. Discharging at the head of the Arabian Sea is the River Indus, from which India takes its name. The Indus is an ancient river, some 35 million years old, and has its source in the high ranges of the Himalayas whose snows now feed it.

The river discharges 200 cubic kilometres of water annually. It also carries to the head of the Arabian Sea some 450 million tonnes of suspended sediment, a mountain each year. This enormous sediment load makes the River Indus the third largest of its kind in the world. It has created the Indus Cone, a 2500-metre thick pile of loose sediment on the floor of the Arabian Sea 1500 to 2000 km away from the mouth of the river. The sediment is so thick that the sea floor is sinking under the weight.

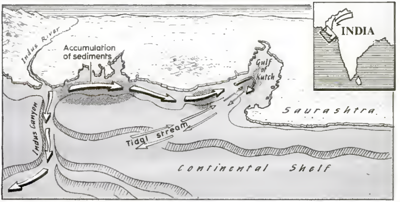
The discharge of sediment and water is greatest during the southwest monsoon season, which lasts from June to September. During this rainy season the Arabian Sea, particularly its northwest part, develops a surface current as the monsoon winds blow over it. The current flows southeast, roughly parallel to the west coast of India, so that during the monsoon season the sediment from the Indus travels, as it should, "downriver" with the current towards the Saurashtra coast.

Some of the sediment emptied into the Arabian Sea settles immediately, giving rise to the Indus delta: the current, called a turbidity current, carries another part into the deeper area of the Arabian Sea as a dense sediment suspension just below the surface of the water, through the Indus Canyon. However, before the sediment-laden surface water actually reaches the Saurashtra coast it comes across an unusual diversion: a tidal barrier.

Some 100 km south of the mouth of the Indus is the Gulf of Kutch—a bay with an area of 7500 km^2. The water in the gulf is up to about 60 m deep, although in much of the gulf it is about 20 m deep. Semi-arid lands surround the gulf which has no river-borne sediment flowing into it. It has a tidal range generally greater than 4 m and in its interior, at Kandla for example, the range is as much as 6 m.

In oceanographic parlance, the gulf is designated as being "macro tidal" because of its very high tidal range. The rise and fall of the tides over this wide range produces strong tidal currents which flow out (the ebb current) to sea at low tide and flow into the gulf at high tide (the flood current). Depending upon the region in the gulf, the current can be as fast as 4 to 5 knots (1 knot=50 cm/second). At the mouth of the gulf and on the adjacent continental shelf it is about 2 knots.

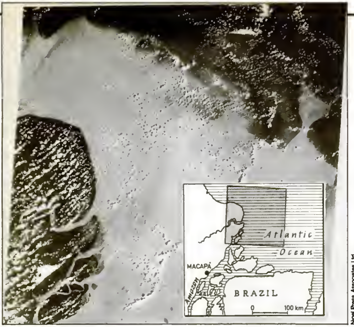
When the sediment-laden coastal current—the southwest monsoon drift—encounters the tidal currents at the mouth of the Gulf of Kutch, the surface current, weaker than the tidal current, is deflected from its southerly flow to the west, away from the coast. The tidal current thus acts as a dynamic barrier sending the sediment from the coast into deeper waters of the continental slope (see left).



The flow of the tides and rivers in the region offshore from the Indus river means that sediment from the Indus ends up thousands of kilometres out in the Arabian Sea rather than near to the coast. So there is no sediment to protect the Saurashtra coast from erosion

Colour photograph/Space Frontiers

This tidal barrier starves the Saurashtra coast of sediment. Coastlines that receive no sediment run the risk of erosion because the protective fringe of sand (the beach) that actually absorbs the impact of the waves is either totally absent or too narrow. Without this shock absorber, the full force of the waves is expended on the rocks of the coast, resulting in their erosion and the consequent retreat of the coastline. The Saurashtra coast has been starved of sediment in this manner for many thousands of years, so what we see today is an extraordinary straight coast with many of the ancient



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The Amazon produces a flow of sediment that travels hundreds of kilometres into the Atlantic, but the currents aren't right to create a tidal barrier

monuments, for example the great temple at Dwarka, inexorably being claimed by the forces of the sea.

Even though the Indus brings many millions of tonnes of sediment to the far reaches of the Arabian Sea, as much as 1500 to 2000 km from the rivermouth, little of it is deposited on the sea floor 100 km from the mouth. This behaviour contrasts with the normal behaviour of another major river, the Amazon. One of the largest rivers in the world, not only in terms of water discharge but also in terms of the amount of sediment it introduces into the oceans, the Amazon flows from the Brazilian highlands into the south Atlantic ocean. It carries some 500 million tonnes of sediment per year. The Amazon deposits much of its sediment on the Brazilian continental shelf and slope, but the sediment-laden plume flows hundreds of kilometres northwest under the influence of the Guiana Current (see above).

An additional peculiarity of the tidal barrier that we have observed is that it acts as a kind of crude filter. Extremely small particles (clay minerals, 2 to 4 micrometres in diameter) pass through the tidal barrier but the coarser particles, of the size of sand, (over 63 micrometres in diameter), are prevented from doing so. How can we explain this process?

Fine particles travel in suspension whereas coarse particles travel as "bed load"—the grains of sand are carried close to or on the sea bed by saltation (sliding and rolling). During the rainy season, when it discharges its waters into the Arabian Sea, the Indus carries both the fine materials, such as clay minerals and mica flakes, which remain in suspension, and the relatively coarse materials, such as quartz, which are carried as bed load.

The discharge is at its peak during the monsoon. Then the Indus's waters are relatively fresh and less saline than sea water. The river water is therefore less dense and "floats" on top of the sea water. As this plume of light water moves away from the mouth of the river, the heaviest particles settle first, close to the river's mouth. The flow carries the suspended particles further and further away, until the plume reaches the region off the Gulf of Kutch. As the gulf is surrounded by semi-arid lands, there is no significant flow of fresh water into the gulf, so its waters have a normal salinity and density for seawater.

The tidal currents carry these waters in and out of the gulf, and on the continental shelf the freshwater plume flows over the tidal stream, carrying with it the suspended load across the mouth of the gulf. But what happens to the bed-load material that is undoubtedly present even this far from the river mouth? Any coarse material that reaches the region off the gulf will encounter the fast tidal currents—the ebb tide is generally but not always stronger—and will be deflected offshore to rest on the continental slope. The upshot of all these processes is that the continental shelf south of the mouth of the gulf is starved of sediment, more so for sand-sized material than for finer material.

But is this at all relevant to any practical problems? Or does it remain a mere scientific curiosity? The answer to the first question is an unqualified yes.

The Gulf of Kutch is one of two regions on the west coast of India identified as suitable for a tidal power station. The other region is the Gulf of Cambay. Briefly, in a tidal power system, electricity would be generated by constructing dams or barrages at appropriate places across the gulf. The barrages would store the flood waters, releasing them during the ebb tide to drive turbines connected to generators. A principal drawback to any tidal power scheme is the accumulation of sediment behind its dams, a problem that becomes acute when the source of the sediment is at the head of the bay or gulf, contributed by one or more river. This is the situation in the Gulf of Cambay, which receives the flow of the Marmada and Tapti rivers.

The Gulf of Kutch does not receive sediments either from its head or sides. On the contrary, its sediment arrives from the open ocean, ultimately coming, as our studies prove, from the Indus. Thus the construction of dams in this area is less likely to cause siltation. For this reason the Gulf of Kutch will be the first choice for tidal power. Even more compelling, the gulf is bordered by desert and semi-desert parts of Rajasthan and Gujurat which are in dire need of energy.

The dynamic barrier in the Gulf of Kutch exists because of the unusual and probably unique juxtaposition of a macrotidal bay downstream of a very large river. We found it relatively easy to detect the effects of the dynamic barrier on the continental shelf because the gulf was making no significant contribution to the flow of sediment.

Dynamic barriers may be rare but they probably exist, albeit in a much attenuated form, where sediment-laden coastal currents encounter sufficiently strong tidal currents at the mouth of some estuaries. They may be the reason why some coastlines are less stable than others.

There is much that we do not know of the physics of dynamic barriers. The phenomenon may have practical implications. For example dynamic barriers may be important in the design and maintenance of dredged harbours. And in the case of waste disposal, a dynamic barrier may deflect sediment and its pollution load away from a coast into deeper waters, thereby reducing the amount of pollution that reaches the shore. ☐

R. R. Nair is assistant director of the National Institute of Oceanography, Goa, India.

Sofia Kovalevskaia: 'muse of the heavens'

Ann Hibner Koblitz remembers a great woman pioneer

WISE '84
WOMEN
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IT IS SOBERING to think that the achievements of 19th century women scientists had so little impact on the attitudes of scientists, educationalists and women themselves that now, a century later, we still need special initiatives such as WISE (Women into Science and Engineering) to increase the numbers of women practising science. Sofia Kovalevskaia would not have been impressed at this lack of progress. She was the first woman in modern times to defeat the formidable opposition and to obtain a doctorate in mathematics (from Göttingen University in 1874). Kovalevskaia was also the first woman outside 18th-century Italy to hold a chair at a research university, the first woman to be on the editorial board of a major scientific journal (*Acta Mathematica*) and the first woman to be elected to membership in the Russian Imperial Academy of Sciences.

Kovalevskaia was at the centre of the mathematical life of her time. She belonged to professional societies in France, in Sweden, and in her native Russia, and engaged in correspondence with mathematicians and other scientists in the foremost scientific centres. For her analysis of the motion of the "Kovalevskaia top", she was awarded the prestigious Prix Bordin of the French Academy of Sciences in 1888. During her lifetime, she was ranked as one of the five or six top mathematical analysts in the world. In our own time, Kovalev-skaia's work is exciting renewed interest among mathematical physicists in the US and the USSR (*The Mathematical Intelligencer*, vol 6, in the press).

But Kovalevskaia was not only an eminent scientist. She was also a champion of women's rights; a supporter of revolutionary political movements in Russia, Poland, and Western Europe; and a participant in the Paris Commune of 1871. She was acquainted with such political, scientific and literary figures as Charles Darwin, T. H. Huxley, George Eliot, August Strindberg, Ellen Key, Fedor Dostoevskii, Ivan Turgenev, R. Wilhelm Bunsen and Peter Kropotkin, to name only a few. And she herself was a writer who used her not inconsiderable literary talent to put forward a progressive viewpoint on social issues.

She was born in January 1850 to a Russian artillery general, Vasilii Korvin-Krukovskii, and his wife, Elizaveta Shubert Korvin-Krukovskaia, daughter of a family of German scholars who had settled in Russia in the mid-18th century. Sofia was the middle child; a daughter Anna was born in 1843, and a son Fedor arrived in 1855. Sofia was more or less ignored by her mother, who divided what little time she had left over from balls and parties between Anna and Fedor. But the lack of affection displayed by her mother was more than offset by the attitude of Sofia's father. He seems to have favoured his younger daughter over his other children, possibly because Sofia showed traits of independence and intellectual curiosity from a young age. The general allowed Sofia to study algebra and geometry with a tutor, and applauded when she solved mathematical problems in her own way. After some opposition, the general even permitted Sofia to be tutored in calculus and analytic geometry—both extremely unusual subjects of study for a well-brought-up young girl of that time.

Mary Evans

The young professor of mathematics at the University of Stockholm

General Korvin-Krukovskii's attention to his daughter was not, by itself, enough to ensure that Sofia would become a scientist, however. Russia (and Europe in general) in the mid-19th century did not provide a congenial climate for the entry of women into the sciences and other professions. Only in Switzerland could women enter university. But the nihilist movement offered the encouragement young women in Russia needed to strive toward higher education and scientific careers.

Early Russian nihilism (not to be confused with later, more extreme doctrines bearing the same name), was an amorphous socio-political philosophy. Its adherents were far from unanimous on many points of tactics and policy. Nevertheless, they agreed on certain general principles. The nihilists believed in the inevitability of a (peaceful) social revolution. They had great faith in the Russian people and the power of education, and they felt that the natural sciences were well on the way to conquering all of man's ills. Morever, the nihilists taught that women were completely equal to men.

Sofia absorbed this corpus of beliefs in her early adolescence, and considered herself a nihilist until her death. Under the influence of these ideas, she decided that it was her duty to seek higher education and to try for a career in science.

In 1868, Sofia married a young nihilist book publisher, Vladimir Kovalevskii, who later became an eminent palaeontologist. The marriage was at first "fictitious"; that is, it was a union contracted solely for the purpose of enabling Kovalevskaia to study abroad, as many other young Russian women were doing. Later, however, Sofia and Vladimir consummated their marriage and had a daughter.

Kovalevskaia's daring extended well beyond her intellectual ambitions. At the age of 15, she took some small part in a Polish rebellion with a brave (though childish) act of public defiance of the Russian military governor of her region. When she was 20, she stole through the lines of Prussian troops cordoning off the French capital to be with her sister and serve in the ambulance corps of the Paris Commune. In her later years, when she was established as a professor in Stockholm, she lent her passport to women revolutionaries for clandestine trips to Russia, and urged the Russian populist emigré Peter Lavrov to make her home in Sweden a sort of underground railway stop for activists fleeing the tsarist regime.

Kovalevskaia was never one to be reticent about her socio-political opinions and beliefs. On her visits to London during her student years in Heidelberg and Berlin, she frequented the salon of the writer George Eliot. On one occasion, Eliot guided Kovalevskaia toward one of her guests. The author made no introduction, saying only that Kovalevskaia must defend herself, since the man was a social Darwinist and did not believe that women were capable of scientific endeavour. Sofia enthusiastically set about trying to convince the man that he was wrong. She did not succeed, but at the end of two hours' spirited debate, Eliot laughingly said that Kovalevskaia had acquitted herself well. Only then did Eliot present Kovalevskaia's erstwhile opponent – the "cosmic philosopher" Herbert Spencer.

Because Kovalevskaia occupied such a unique position in the scientific world of late 19th-century Europe, she was a celebrity during her lifetime. One way or another, she had encounters with many of the prominent intellectuals of her day. When she was young, the scientists Hermann Helmholtz, Gustav Kirchhoff, Rudolf Virchow, Dmitri Mendeleyev, and Ivan Sechenov thought so highly of her

Ann Hibner Koblitz is a historian from the University of Washington, Seattle, US. She is the author of *A Convergence of Lives* (Birkhauser, 1983), a biography of Sofia Kovalevskaia.

mathematical gifts that they persistently advocated Kovalevskaia's admission into institutions of higher education.

The playwright Henrik Ibsen felt that the only medium that could do justice to the story of Kovalevskaia's life would be poetry. As if in agreement with Ibsen, the British algebraist J. J. Sylvester, a firm supporter of higher education for women, wrote a sonnet characterising Kovalevskaia as the "Muse of the Heavens". (He also expected her to be pleased that his assistant called her "the first handsome mathematical lady I have ever seen!")

Kovalevskaia had detractors as well, especially among those who opposed women's entry into higher education and the professions. The chemist Wilhelm Bunsen was so incensed that she had persuaded him to allow her access to his lectures and laboratory that he called her "that woman" and spread scurrilous stories about her. The writer August Strindberg was indignant that Stockholm University had dared to offer a professorship to a woman, and called Kovalevskaia a "monstrosity" because of her mathematical abilities. And the physical anthropologist Cesare Lombroso hastened to assure the European educated public that Kovalevskaia was only an *apparent* exception to his statement that no woman could be a genius. Kovalevskaia was an imitator, not an originator, Lombroso asserted.

Sofia Kovalevskaia died of pneumonia in February 1891, at the age of 41. She was at the height of her mathematical powers and reputation, and was just beginning to make a name for herself as a writer as well. She was mourned by mathematicians, scientists, intellectuals, feminists and other social activists throughout Western Europe and the Russian empire. These people remembered her for her mathematical creativity, championship of women's causes, and concern for political issues. Today, she can be viewed also as one of the earliest role models for girls thinking of becoming scientists. □

Down-to-Earth approach to school science

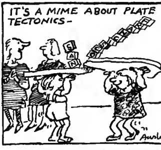
David Dineley believes that the curricula need enriching

WHO CARES what and how much science is taught in schools? How many scientists are really prepared to say that they do—or are ready to encourage the teachers? School teachers often claim that the curricula they must follow are already overflowing. Just concentrating on the basics of science—biology, chemistery and physics—is burden enough for them.

Science, however, is *not* just physics, chemistry and biology. But most teachers would object to additional science, be it Earth science, astronomy, psychology or whatever. Yet, at our peril we neglect to introduce into the early years at school a sight of these disciplines.

In my own field of geology, the dilemma is acute. Twenty years ago it became clear that the surface of the Earth consists of massive movable plates of "rock". This revelation and its concomitant implications set in train a scientific revolution that has grown almost exponentially. The subject has become so all-encompassing that it has widely taken the title of "Earth sciences". It provides us with knowledge not only of the structure and evolution of the Earth, but also of our environment. The major advances in our understanding of the biological, chemical and physical sciences have been matched by recent developments in Earth sciences—those of the solid Earth itself, and of the waters and atmosphere that surround it.

Plate tectonics, the space programme and space fiction, dinosaurs, conservation, pollution, dwindling fuel and other reserves have all encouraged a growing interest in the Earth sciences, in schools. The teachers have not been slow to respond. Already there are O- and A-levels in Earth sciences, and some teachers, especially those in the Association of Teachers of Geology and on the Education Committee of the Royal Society, want more of the subject in the general school science curriculum. The Secondary Science Curriculum Review, a project sponsored by the Association for Science Education and the Department of Education and Science, is also interested in promoting new methods for such teaching.


IT'S A MIME ABOUT PLATE TECTONICS -

In recent years, unfortunately, economies have hit the teacher-training sector of Earth sciences, and there just are not enough teachers coming through. Only three university schools of education in England and Wales now offer special training in Earth sciences for secondary school teachers. Keele, Aberystwyth and Bath between them will produce rather fewer than 40 such teachers in the coming years—unless new measures are taken.

All things considered, however, it is unlikely that the number of teachers of Earth sciences in schools can be increased even marginally. Clearly, teaching in primary as well as secondary schools has to respond to the need for *all* children to receive a good basic grounding in science as early as possible. Pupils may later wish to take more interest in one branch of science than others, but the later this can be left the better—maybe as late as A-level.

Meanwhile, the basic sciences themselves could be enriched by a host of examples from the Earth sciences. How better to get across the importance of understanding gravity than an explanation of what the Seasat satellite and altimetry have revealed of the Earth surface below the deep oceans? What better practical application of faunal assemblages and types than their use in stratigraphy and the search for petroleum? Geological dating techniques provide a practical lesson in isotope chemistry. The list is infinite.

As a graduate, the Earth scientist needs all the physics, chemistry and biology that he or she can handle so as to compete in the scramble for jobs in the Earth sciences. Job opportunities are more varied now than ever before, but the chances are that demand will not rise much more.

All this is very well for the graduate, but the graduating class of 1983 (about 900 in Earth science: about 33 000 in science, engineering and medicine) was tiny in comparison with the numbers leaving education at an earlier age. Many of these school leavers will need to understand more of science than they do at present. And, as the report of the Royal Society's Study Group on Science Education implies, scentists themselves should help.

Scientists of all sorts should be encouraging the British Association for the Advancement of Science, museums, science centres and resource centres for young people. Also in need of encouragement are extra-curricular science-learning activities and their teachers. A few more scientists speaking out in support of the cause might make all the difference to a modest campaign.

The American Geological Institute recently declared that geological education in schools and colleges should be more visibly, audibly *and actively* encouraged by the professional geologist. The British professional should be exhorted in the same way, especially, I believe, the Earth scientist. Now is the time for all good scientists to come to the aid of their progeny. □

Professor David Dineley is head of the Department of Geology at the University of Bristol.

Sensitive information

ONE OF our reporters went down to the Public Record Office in Kew the other day to see what sort of 30-year-old secrets the government has released for public consumption. As most readers will be aware, Britain keeps its government papers secret for at least 30 years (unless they are leaked, intentionally or otherwise, to the press). In some special cases, for very sensitive secrets, this can be extended to 50 years, or even a hundred.

Our reporter was interested to find that one set of Ministry of Defence files—called the Scientific and Advisory Council Papers—should have been brought up to date (as it were) so that the last entry included 1953 documents. He noticed, however, that the last entry was 1949. This is not because the 30-year rule had been extended, but, apparently because the Ministry of Defence is short of suitably qualified staff to act as "weeders"—those who pick out the more sensitive information in the files to stop them appearing in the Public Record Office. Our reporter wants to let the ministry know that he would like to volunteer his services for this arduous task, free of charge. □

And more anniversaries . . .

Mick Hamer outlines some transport celebrations for 1984

ONE-HUNDRED-AND-FIFTY years ago Thomas Telford died, Gottlieb Daimler was born, and the architect Joseph Aloysius Hansom patented the cab that bears his name.

Telford died in Westminster, London, on 2 September 1834. He had been born in Scotland, in 1757, of poor parents and was self-educated. He worked on farms and became apprenticed to a stonemason. After employment in Edinburgh and London, he was appointed county surveyor of Shropshire. Telford quickly became the foremost engineer of his day. He helped to pioneer the construction of cast iron bridges and suspension bridges. His suspension bridges over the River Conwy and the Menai Straits still stand, although the chains from which the bridges are suspended have been replaced by modern cables.

Telford also improved a number of roads, including the great London to Holyhead road—the main route for journeys between the English and Irish capitals. His method of construction was to build lower courses of masonry, topped by a layer of gravel. The stone layers were expensive, and most roads were built in the lighter style developed by John Macadam. Telford became the first president of the Institute of Civil Engineers in 1820.

Joseph Hansom drove his cab from Leicester to London to patent it in 1834. It was a development of the cabriolet, whence the word "cab". The Hansom cab was a two-wheeled, covered vehicle drawn by one horse and had seats for two passengers inside: the driver was mounted on a raised seat behind. The Hansom became as common on the streets of London at the turn of the century as black cabs are today. The motor vehicle rapidly replaced the Hansoms before the First World War, although a handful were still licensed for hire in the 1920s.

Daimler who was born at Schorndorf, Stuttgart, on 17 March 1834, was in part responsible for the demise of the Hansoms and the rise of the motor vehicle. A pioneer of automobile engineering, he patented one of the first successful petrol engines. Initially he used the engines to power mopeds and only turned to making cars in the 1890s. He died in 1900. Daimler had worked for Nikolaus Otto, who had invented the four-stroke internal combustion engine. In 1883 Daimler moved to Cannstatt and began a series of experiments which led to his lightweight high-speed petrol engine. The experiments were not always successful and after one particularly explosive failure neighbours called for the police.

In 1885 Daimler fitted the engine to a bicycle, and patented it. The engine had a single air-cooled cylinder and ran at the unprecidentaly high speed of 700 rpm. The engine drove the rear wheel by a leather belt, which was so arranged that the tension in the belt slackened when the brake was applied.

The following year Daimler built a four-wheeled motor vehicle. He went on to found the Daimler car manufacturing firm in Cannstatt, which later became the Mercedes firm.

One hundred years ago, Sir Charles Algernon Parsons patented his steam turbine. The idea was not new. Almost 200 patents for turbines had been granted between 1784 and 1884. The difference was that Parson's design, for a staged rotor that controlled the expansion of steam, was practical. Parsons proved his invention to devastating effect at the Spithead review of 1897. His small boat, the Turbinia, which had a maximum speed of 35 knots, darted among the great ships of the line, embarrassingly overtaking the flagship Victoria and Albert with the Royal Party aboard, and easily outstripping destroyers that tried to catch it. The next day, the *Daily Mail* thundered: "if that shrimp of a turbinet comes to anything all these black and yellow leviathans are done for". Parson's steam turbine rapidly gained acceptance, and when Cunard launched its giant liner the Mauretania in 1905 it had steam turbines.

Conwy suspension bridge, after an original drawing by Percival Skelton

Parsons became a Fellow of the Royal Society in 1898 and president of the British Association in 1919-20. He died in 1931.

Auguste Piccard, a physicist, was born in Basel on 28 January 1884. His was a switchback life of highs and lows. In 1931 he broke the world altitude record in a balloon, ascending to 15 800 metres. Because of a blocked valve, the balloon had to wait until night to descend. This delay caused an overnight sensation, because without radio contact he had been given up for dead. In 1932 he broke the record again with an ascent of nearly 17 000 metres. However, Piccard was not primarily interested in breaking records. He made the ascent to measure cosmic rays.

Later in life Piccard turned to descents into the ocean. He invented the bathyscaphe, which was based on the design of a balloon. To rise, a balloon jettisons ballast. The bathyscaphe also released ballast to rise. An experiment, from a French navy ship commanded by Jacques Cousteau, was only partially successful in 1948. But five years later, Piccard descended to 3150 metres. His son Jacques later took the bathyscaphe down to 10 900 metres. Auguste Piccard died in 1962. □

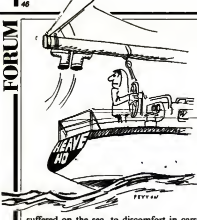
Bootstraps and armbands

John Stansell on technical remedies for *mal-de-mer* and backache

ALTERNATIVE MEDICINE does not often surface at something like the London Boat Show, but this year's event threw up two most unlikely ideas. One is a wearable remedy for motion sickness, while the other, glorying in the name "inversion therapy boots", extols the advantage of hanging upside down for a brief spell now and again.

The seasickness cure comes from a source as incongruous as the remedy itself—the British firm Lewmar, which has developed the technology of winches and other sail-control equipment to such a level that it is now one of the world leaders. The Lewmar cure is a strap that you wear on your wrist, much like the one that carries your watch. But instead of a timepiece, there, in the centre of the woven nylon band, is a small plastic hemisphere, about the same size as a marble cut in half. This semimarble is glued to the inside of the strap so that when you wear it it presses on your wrist—just where all those veins are.

The theory comes from the Japanese equivalent of acupuncture. By applying pressure to suitable parts of the body, so the theory goes, you pass instructions to the central nervous system that persuades it to view things differently. Theory has it that the relevant pressure point for motion sickness is on the wrist. The Travel Band is recommended for easing all forms of nausea induced by travel—from that



suffered on the sea, to discomfort in cars and even to space sickness.

Naturally, there is no conventional scientific evidence that the Travel Band works. Trials by the curious have shown that it works wonders for some, has a half-hearted effect on others, while it is useless for a third group. Perhaps a *New Scientist* reader somewhere knows more. It would be good to hear from him or her.

"Inversion therapy", however, is all to do with allowing the spine to recover from the daily maltreatment that we all give it by standing upright. According to Amsport, a company based in Cirencester that markets the kit enabling you to hang upside down safely, the moment you leave your bed in the morning your vertebrae come under pressure. (It seems a logical theory and provides, in any event, a good reason for perhaps spending more time in bed.) But back to the claim. If you hang by your ankles each day for a while (no more than 3 minutes at a time initially) you not only ease the muscles but you also grow taller (for a short while anyway).

This relaxation of the muscles does wonders for you, says Amsport, relieving stress, making you feel healthier and so on. Hanging upside down is all the rage in the United States, Amsport tells me, and it has been given respectability by several university research reports, which I am still waiting to see.

Amsport gets its share of this action by selling the "boots". They are, in fact, anklets with hooks. You can flip the hooks over a special frame, over bolt-on bits to go on doors, or you can go the whole hog and buy a tilting camp bed that enables you to go inverted in comfort.

I am intrigued by a mischievous idea that comes to me. What if you wore the boots and the strap while travelling on British Rail's Advanced Passenger Train? First you could pack more people in. Secondly they would then possibly be protected from the travel sickness that the APT causes, while avoiding both the stress of waiting for the tilt mechanism to fail and the failure itself? But perhaps such techniques are too late to save the APT. □

Thistle diary

Tam Dalyell proffers some more parliamentary notes

MOCKING PEOPLE'S names is distasteful, and a habit not to be indulged in . . . However, ever since my family became friendly with a manager of the then Anglo-Persian Oil Company, a Mr Gas, I have always been fascinated by how frequently a name ties up with a business or cause. I say this because I've been puzzling over who could possibly be better than the new Hertfordshire Conservative MP, Marion Roe, to defend the Atlantic salmon?

At question time, Roe demanded that the EEC's Council of Ministers should control excessive fishing on the high seas, and in particular off the coast of Greenland and the Faroes. John MacGregor, Minister of State at the Ministry of Agriculture, Fisheries and Food, told Roe that the EEC limited catches of salmon in Greenland waters. It also insisted on the limitation of Faroese catches in the context of the European Community-Faroese fisheries agreement. Roe claimed the present controls were not effective and better policing was essential. As stocks of salmon throughout the entire Atlantic region were being overfished, and the runs of salmon were declining. She wanted the minister to do something about improving stocks and controlling netting.

MacGregor claimed that evidence on the decline of salmon was patchy. The Greenland and Faroese salmon fisheries would be closely examined by the West Greenland and North Atlantic Salmon Conservation Organisation at their meeting in May. New scientific advice on these fisheries had been requested from the International Council for the Exploration of the Sea. Those at the May meeting, should decide on the appropriate level of catches.

* * *

IT IS STRANGE to see conferences attracting enormous publicity and controversy, and then to find that there is little follow-up. The third World Wilderness conference was held in Inverness and at Findhorn on the Moray Firth, bringing in such well known names in the field as Sir Laurens Van der Post from South Africa, and Felipe Benavides from Peru.

Because the conference was opened by the Secretary of State for Scotland, George Younger, I thought it legitimate to quiz him on any follow-up about a wilderness policy for Scotland. He turned the problem over to one of his junior ministers, Michael Ancram, who in four paragraphs presented the Scottish Office view. I feel it deserves to be reproduced *in toto* because so many readers have written to me about remarks I have made on wilderness in this column.

"There have been suggestions in the past for a specific 'wilderness' policy for Scotland but the conclusion reached continues to be that there is no evidence that any new initiatives within the existing well-tried development control procedures would materially improve the safeguards already in force to protect the more remote, sparsely-populated parts of the country; or indeed that they are at special risk under these procedures.

"Putting aside the very real problem of establishing a generally acceptable definition of 'wilderness', you will be aware that the word arouses strong feelings, particularly in the Highlands. The designation of wilderness areas and a statement of restrictive policies for them would certainly be highly controversial. There would be long arguments involving both those who feel that Scotland's wild areas are not real 'wilderness' in the international use of the term, and those who consider that designating areas tends to attract walkers to them and leads both to deterioration and to the need for facilities, all of which destroy the very quality they wish to protect. Despite the recent conflicts over Knoydart and Cairngorm there seems doubtful benefit to be gained from any new controls in respect of wild remote areas.

"A general protection for land from unsuitable development has after all existed for some 40 years in our planning system and particular safeguards have been developed for the scenic and scientific value of land. All these are subject to regular review and up-dating as necessary, the most recent major developments in habitat protection having been introduced in the Wildlife and Countryside Act 1981.

"The importance of protecting the scenic areas of Scotland with which the wilder areas are often coincidental is a matter of constant concern to the Secretary of State and the Countryside Commission for Scotland. Unitary management in a planning context, in the sense of achieving common approach to intrusive development proposals, is already given practical expression in control procedures,

ENIGMA

No 250

A couple of sevens

by Eric Emmet

THE FOLLOWING long-division sum with most of the figures missing comes out exactly:

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Find the missing figures.

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 1 March 1984. Please send entries to Enigma No 250, New Scientist, *Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 247, "Metacrisis", was Lewis Banks of Chelmsford, Essex.*

Answer to Enigma 247

Metacrisis

Sixty six

Each pair must lack something different. What each pair lacks every other person must have.

produced in September 1980, under which certain areas of land were designated by the Secretary of State as National Scenic Areas. Within these areas planning authorities are required to consult the Countryside Commission before granting approval for certain classes of development, and in the event of there being disagreement between the planning authorities and the commission as to how the application for planning permission should be determined, the application must be notified to the Secretary of State who will decide whether or not he should call-in the application for his decision."

* * *

I AM A parliamentary observer, albeit an unsatisfactory one, of the Fauna and Flora Preservation Society (FFPS)—unsatisfactory because the society's meetings are on Tuesday afternoon, just when Prime Minister's Question Time comes up. However, I do read the FFP's admirable magazine *Oryx*. In the January edition, Ian Strange argued that the Falkland Islands should be turned into some form of international wildlife reserve. As a consequence of reading this I wrote to the Foreign Secretary, who did not offload the letter to a junior minister, but answered it himself. It is worth regurgitating what Sir Geoffrey Howe said:

"MAKES YOU FEEL YOU'RE DEFENDING SOMETHING WORTHWHILE"

"The Falkland Islands' government already takes the need for wildlife conservation very seriously, and legislation to protect the natural flora and fauna of the Islands has been in force for many years. Two ordinances, the Wild Animals and Birds Protection Ordinance 1964, and the Nature Reserves Ordinance 1964, repectively, authorise the establishment of 'wild animal and bird sanctuaries' and 'nature reserves'. Some of each have already been designated. There are no plans at present to create an international wildlife reserve on the Falklands. However, this does not rule out the possibility of something of the kind in the future. A possible framework might be provided by the 1972 UNESCO Convention for the Protection of the World Cultural and Natural Heritage, which the United Kingdom is to ratify shortly. Assuming that the Falkland Islanders agree to be included, this convention would offer the opportunity for all or parts of the Falklands to be designated as 'natural heritage' areas recognised as being of outstanding universal value."

* * *

THE SCOTTISH Home and Health Department has given £44 000 to Dr Anthony Girdwood and Dr Patricia Monaghan of the Department of Zoology at Glasgow University to catch and to examine about 10 000 herring gulls in Scotland. Raise your eyebrows you may, but actually it is a potentially important project to further medical knowledge about recently identified bacteria that cause food poisoning. Birds carry salmonella and other bacteria such as campyloacter that can be responsible for distressing gastroenteritis in human beings.

Once the scientists get their birds, they intend to measure them, give them an enema, and take samples for the laboratory. They then put a ring on the bird's leg and hope subsequently to be able to monitor their movement. The whole operation is said to take only two minutes and the birds do not appear to mind too much. The Glasgow scientists claim to be able to catch some 200 birds at a time. If the project can achieve a breakthrough in diseases of the gut, the money will have been well spent. I'm serious. It's not just verbal diarrhoea! ☐

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LETTERS

Growing pains

Hilary Roberts, in her article "Grow your own personalities" (2 February, p 12), argues that the existence of multiple personality disorder in some way contradicts the well-established facts about the genetic determination of intelligence and personality. It is not at all clear why this should be so. The different personalities and degrees of intelligence appearing within the single person suffering from this disorder can be more easily explained in terms of malingering.

There is no difficulty for a person with an IQ of, say, 140 to record one of 60 if he sets his mind to it, and during the war, when I was working at the Mill Hill Emergency Hospital, I encountered many cases of malingering with soldiers trying to get out of the army by pretending to be mentally defective.

Psychometricians have worked out ways of detecting malingering, by looking at the distributions of successes and failure as related to the difficulty level of items, but this has not been done in the cases of multiple personality disorders. Equally it has often been shown to be quite easy to fake different personality inventories. The published data demonstrate to some extent the gullibility of investigators who are unwilling to test the genuineness of the phenomena reported by suitable experimental designs which would exclude malingering.

The same argument applies to many of the physiological changes reported. As Professor Lykken has shown in his book *A Tremor in the Blood*, it is quite easy to fake many of the physiological indices of emotion customarily used, and this would have to be controlled for if reports of multiple personality disorder are to be taken seriously.

Incidentally, Hilary Roberts is quite wrong in thinking that I was thinking of the latencies of evoked potentials in the brain when arguing that we were getting to know the physiological basis of intelligence; latencies show quite a poor correlation with IQ accounting only for something like 10 per cent of a variance. I was referring to the complexity and the variability of evoked potentials, which is quite a different matter. If it could be shown that with respect to these particular measures the different personalities in multiple personality disorder disagreed, then I think we would have to take Hilary Robert's argument seriously.

As it stands it is difficult to know how much if any weight to give it.
H. J. Eysenck
Institute of Psychiatry

* * *

Dr Hilary Roberts claims that multiple personalities can be created artificially by using hypnosis. How? The evidence for hypnotic trance is on a par with that for reading your humps. As long ago as 1962, Sarbin proposed that the term "hypnosis" be stricken from the professional vocabulary of psychology. (Needy academic believers may like to know that the American mentalist-magician Kreskin is still holding open his offer of $20 000 for a single demonstration of genuine hypnotic trance!)

Hilary Roberts goes further: *self*-hypnosis is offered as an "explanation" for multiple personality disorder. And "personality and IQ can be self-determined, albeit unconsciously".

How do you determine things in the absence of consciousness? Is this how decisions are sometimes made to accept articles for print?
Lewis Jones
London SE26

Empty heads

Tom Wilkie's article "Chevaline's empty heads" provided a useful review of what will turn out to be, without doubt, two of the most important books of 1984 (2 February, p 5).

While it is impossible to do justice to the wealth of meticulously researched material in such a short article, may I point out that Dr Wilkie conveyed two erroneous impressions in his comments on John Simpson's *The Independent Nuclear State: the United States, Britain and the Military Atom.* Each time the problem concerns the exact nature of the fissile exchange agreements entered into by the British and American governments.

First, while there was a civil agreement made on fissile material exchange in August 1966, this was not the first such civil agreement. As Simpson's book clearly states, on 15 June, 1955, parallel civil and military agreements were signed, the civil one allowing non-weapons grade U-235 to be transferred. This interpretation is reiterated by John Baylis in his study *Anglo-American Defence Relations, 1939-1980.*

Secondly, although the 1958 Agreement for the Co-operation on the Uses of Atomic Energy for Mutual Defence Purposes, signed 3 July, was the *basis* for future fissile material exchange, it only allowed for the transfer of US originated U-235 for submarine cores to the UK; with no reciprocal agreement for the transfer of British originated fissionable materials to the US.

However, on 7 May 1959 an amendment to the Anglo-American agreement (Article III bis) allowed for the reciprocal transfer of "special nuclear (fissile) materials". This agreement has been updated every five years, the latest being on 5 December 1979.

Simpson suggests that is was an announcement, by the then Paymaster General, Reginald Maudling, of 1 August 1958, in which three of the new civil nuclear power stations would be modified to enable them to produce military-grade plutonium, that was the basis of the arrangements to provide plutonium for the US under the Anglo-American military agreement.

However, the Ministry of Defence issued a statement concerning "The production of plutonium suitable for weapons in the new power station programme as an insurance against future defence needs", on 17 June 1958. This was followed up by Parliamentary questions to the Scottish Secretary about the possible use of Hunterston for such purposes, and to Maudling on 24 June 1958. When asked by Mr Mason whether the modifications would be a "disgusting imposition on the peaceful nuclear energy programme", Maudling replied, *inter alia* "The only imposition, on the contrary, would have arisen if the government had met our defence requirements for plutonium by means far more expensive than those proposed in this suggestion".

The following year, on 22 June 1959, Maudling stated that as a result of the Anglo-American agreement, only Hinkley Point would be modified.

Thus it can be seen that the militarisation of the first British "civil" nuclear reactor programme was integrally linked to the complications of Anglo-American defence relations—a point Simpson's book argues with great force for this period and successive periods in Anglo-American relations.

It would be nice if the publisher, MacMillan, could rapidly bring out a paperback version, however, as the current cost of £25 will

GRIMBLEDON DOWN

Bill Tidy

I DISAPPROVE OF CHEATING, WICKS, AND I ACTED AGAINST MY BETTER JUDGEMENT IN ALLOWING YOU TO FIELD TEST...
DRESSING ROOMS
..SUPPOSED NEW TELEPORTATION TECHNIQUES DURING A GAME. LOSING 56-0 HAS CLEARED MY CONSCIENCE A LITTLE, AND..
..IT NOW SEEMS FAIRLY OBVIOUS THAT... THIS... PERSON IS NOT THE PARANORMAL GIANT HE CLAIMS TO BE.
MR. MURPHY, I THINK-
IF THATS HOW YOU FEEL, YOU CAN GET STUFFED. GOODBYE!
CAN'T UNDERSTAND IT, SIR. IT WAS LOCKED AND GUARDED AT ALL TIMES!

restrict its circulation to a narrow few, notwithstanding its broad importance to current debates.

David Lowry
Energy Research Group
The Open University
Milton Keynes

Raleigh's research

Dr Johnny Muirhead-Thomson, (26 January, p 2) makes a number of serious allegations about the running of Operation Drake and Operation Raleigh. The question is, does the accuracy of his accusations match the eloquence of his rhetoric? He gives the impression of a detailed knowledge of both enterprises, but in fact his contribution to Operation Drake died away even before the expedition set sail.

Publicity surrounding these expeditions often appears sensational. However, Operation Drake and Operation Raleigh depend on sponsorship from the private sector which is largely gained through publicity. To some extent, the press have to be given what the public wants to hear, otherwise it will not get printed. Many worthy stories about the scientific activities of Operation Drake were filed which did not see the light of day because they were not regarded as good copy. The other point here is that young people respond very strongly to the idea of challenge and trial—they do like to test themselves. Neither sponsors nor young people would come forward if the work appeared boring and predictable.

I agree with Dr Muirhead-Thomson that the aim of a scientific expedition should be to get the work done in spite of adverse conditions. This is precisely what Operation Drake did. Large base camps were set up with all facilities which serviced small forward camps. I totally disagree that you can avoid living in the environments you are studying when making hourly observations, for example. Martyrdom is not usually compatible with successful research and if Dr Muirhead-Thomson had actually been on Operation Drake, he would have realised that this was an axiom dear to our hearts.

With regard to the problem of achieving much of scientific value in a three-month period, the publications of over 50 research papers and formal reports on Operation Drake indicates that some kinds of research are well suited to this limited time scale. On Operation Raleigh the emphasis will be on comparative projects with three months each in a series of sites, with standardised techniques producing data which no other organisation can provide in such quantity or so cost-effectively. For example, we are carrying out a major comparative survey of coral reef diversity in the Caribbean, Pacific Ocean and coastal waters of Southeast Asia.

The undoubted value and need for long-term studies in selected sites should not obscure the fact that we have a pressing need for short-term comparative studies in many environments–partly to decide which long-term studies are particularly needed. The idea that the three month stay merely frustrates the novice, overlooks the fact that on the Operation Drake/Operation Raleigh system these novices work with seasoned scientists, who, in return for the effort taken up in training the young, are able to carry out labour-intensive work that would otherwise be impossible.

Brief encounters with primitive cultures were not a major feature of the scientific programme of Operation Drake and form no part of the research plans for Operation Raleigh. A general awareness of cultures other than one's own through acquaintance with local inhabitants can, arguably, be regarded as a good thing; provided the integrity of the others' cultures is respected. We are well aware of the need for care in this respect.

The research committee of Operation Raleigh has been meeting for 18 months, building on the strengths of Operation Drake and avoiding the weaknesses. While we cannot have permanent bases of the kind Dr Muirhead-Thomson advocates, we have got two 6 month bases and 12 month follow-ups in a few special cases; e.g. decomposition studies on rainforest leaf litter.

On Operation Raleigh, we have already had a "long cold look" at what we are doing and are well ahead on tailoring our work to meet the constraints within which we operate. A charge of "window-dressing" does not stand up on Operation Drake, and neither will it do so on Operation Raleigh.

Dr Steven Sutton
Chairman Research Committee
Operation Raleigh
London E1

Sexist talk

I note in your columns an increasing tendency to use the personal pronoun "she" to refer to persons or creatures of unspecified sex. Irrespective of the feelings of chauvinists on both sides of the sexist divide, this is quite clearly incorrect. It arises from an unfortunate confusion of sex with gender, a linguistic device which is not inherently sex-related.

"AND ALL WHO SAIL IN HIM HER OR IT..
Austin

In English, a language almost entirely devoid of grammatical gender, the personal pronoun "he" has always possessed both masculine and common genders, whereas "she" is solely feminine. To refer to a member of any class, therefore, as "she" is to exclude, specifically, all male members of that class. Female members of a class are not similarly excluded by the use of "he".

New Scientist has long been very highly regarded for the excellence of its English. Please do not allow that reputation to be damaged in pursuit of current sociopolitical faddishness.

Mike Shields
Nuneaton
Warwickshire

Antarctic airstrip

Your report on the airstrip being constructed, ostensibly for French scientists, on the Antarctic mainland (*This Week*, 26 January, p 4) highlights a very serious problem facing this last, vast, unspoilt continent.

Construction work on the project has indeed ended since the short season during which the operation can proceed has now closed and not due to any immediate change of heart by the French authorities. This type of work, along with the inherent environmental damage, will continue and increase unless radical protection measures are introduced into the Antarctic Treaty system.

Fuelled by the prospect of large mineral wealth, the Antarctic Treaty powers are hurtling towards a minerals agreement in which environmental protection will be pushed aside in the face of the requirement to accommodate all treaty parties. Any such agreement must be able to account for the desires of both members who claim territory and those who don't recognise their fellows' claims.

At the recent minerals discussions in Washington many delegates agreed that the French airstrip was in breach of the parties "Agreed Measures for the Protection of Antarctic Fauna and Flora" but that they were powerless, under the Antarctic Treaty, to do anything about it.

This colossal failing in the treaty system would be overcome by the establishment of an Environmental Protection Agency which would ensure a full international scrutiny of construction proposals before any work begins. Greenpeace put this concept forward at the Washington meeting and it will be a measure of how seriously the Treaty powers take environmental protection to see if this solution is accepted.

Mark Glover
Greenpeace
London, N1

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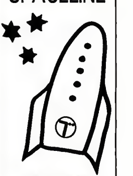

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to become head of our growing Corrosion Research Division near Pretoria.

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For an application form, ring 01-242 1766 during normal office hours or send personal and career details, including phone number, to the Scientific Counsellor, Chichester House, 278 High Holborn, London WC1V 7HE, **quoting ref. 11/1/1157 clearly on your envelope and letter.** All Interviews will be conducted in the UK.

This vacancy is open to members of both sexes regardless of colour, race or creed.

The CSIR is a statutory organisation that undertakes and supports research in various fields of Science and Technology – for the benefit of all peoples within the Republic of South Africa – through 5,000 staff at 30 institutes, laboratories and service departments nationwide

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Applicants should preferably have expenence in the area of meat science or food engineenng. Commencing salary is in the range £6312–£8082 pa. initial placing depending on experience and qualifications. Further particulars may be obtained from the Personnel Officer, The Queen's University of Belfast, Northem Ireland BT7 1NN. Closing date: 16 March, 1984. (Please quote Ref 84/NS.)

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Salary scale: £5151 to £6036 plus £1220 London Weighting.

Application forms and further details are available from the school. Completed application forms should be returned to EO/Estab 3a, Room 255a, County Hall London SE1 7PB, within 14 days of the appearance of this advertisment.

All applicants will be given equal consideration irrespective of sex, age, disabilities, race, colour, nationality; ethnic or national origins, marital status, sexual orientation, family responsibility, trade union activity or political belief.

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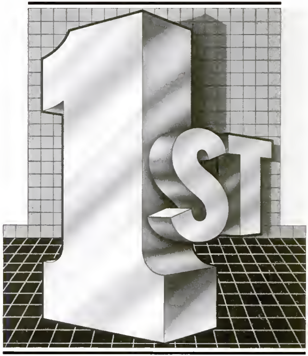

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The successful applicant will preferably be educated to Honours Degree standard or above and should have a proven track-record in the Pharmaceutical or toiletry industry. Experience in the hygiene/oral hygiene fields would be advantageous though not essential.

The work will include some travel abroad and liaison with production and marketing departments on new development projects.

To the right person we will offer an attractive salary and excellent working conditions. Other benefits include company car, pension sheme, BUPA membership, subsidised restaurant, flexible working hours and sports and social facilities.

Relocation expenses will be paid where appropriate.

In the first instance please write enclosing curriculum vitae to Mrs Jeni Money at the above address, or alternatively telephone her on Egham 34422 for an application form or further information.

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Due to expansion we require an additional Chemist

The requirement is for a graduate level Chemist, primarily to work on the development of new products and modifications to existing products. Work would also entail assisting in general laboratory duties, technical services and quality control.

Experience in an industrial laboratory associated with household cleaning products and expertise in formulating detergents plus a knowledge of adhesives would be beneficial.

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Applications and full relevant details, in writing please to:

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Department of Physiology

SENIOR LECTURER/LECTURER

Applications are invited from suitably qualified persons, regardless of sex, race colour or national origin, for appointment to the above posts in the Department of Physiology. Applicants should hold a higher science degree or a medical or veterinary qualification.

Successful applicants will be expected to participate in the teaching and research programmes of the Department. The major research interests of the Department of Physiology include: cardiovascular physiology, neurophysiology, thermoregulation, biomechanics/energetics, mathematical biology, and computer simulation.

The Department offers outstanding opportunities for research. In the case of registered medical practitioners arrangements can be made for a remunerated part-time attachment to a clinical department for the purpose of patient care and research.

The salary will be in the range: Senior Lecturer: R22 533–R28 185 pa. Lecturer: R14 880–R25 080 pa. A pensionable allowance of 12% is also payable.

The initial salary notch will determined according to the qualifications and experience of the successful applicants. Benefits include an annual bonus, medical aid, a housing subsidy for those eligible and substantial removal aid.

Intending applicants should obtain the information sheet relating to this post from the Secretary, South African Universities Office, Chichester House, 278 High Holborn, London WC1V 7HE, England or from the Assistant Registrar (Academic Staffing), University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg 2001 South Africa with whom applications should be lodged not later than 31 March, 1984.

UNIVERSITY OF SURREY

Department of Electronic and Electrical Engineering

RESEARCH FELLOW IN TERRAIN FEATURE ANALYSIS USING LASER RADAR

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The work is a continuation of a two year project concerned with the design and development of the laser radar systen and is supported by the Military Vehicles Experimental Establishment.

Experience in image processing/microprocessor systems/opto-electronics would be an advantage.

This post which is in the Satellite and Telecommunications Research Group is for 21 months in the first instance, at a salary of up to £8975 pa depending on age and experience with superannuation under USS conditions.

Applications in the form of a cv (three copies) including the names and addresses of two referees should be sent to the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey GU2 5XH by 8 March, 1984, quoting reference 235/NS. Further particulars for this post are available from the same address. Please telephone Dr Jeans on Guildford 571281 Ext 672 if you wish to discuss details of the post.

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GEC Research Laboratories

Hirst Research Centre, Wembley

Reporter/ Writer

The Institution of Electrical Engineers requires a Reporter/Writer for its monthly newspaper, IEE News, to report on conferences, meetings, lectures etc. and to research and write articles on technical and professional topics relevant to the interests of the Institution's 80 000 members.

Candidates should have a sound technical background, and the ability to write clearly and accurately on a wide range of topics in electrical/electronic engineering and on professional matters reflecting the interests of the Institution. Formal training may be given where an applicant can demonstrate an aptitude for journalism rather than specific experience.

The post is based at the Institution's Publishing Department in Stevenage, but frequent travel to the Institution's headquarters in London and occasionally to other parts of the UK is necessary.

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The Water Research Centre is looking for a graduate in science or engineering, preferably with a library/information science qualification, to fill the post of Information Officer at its Environment Directorate, near Marlow, Buckinghamshire. The work will involve managing and developing the existing library resources, literature searching and handling general and bibliographic enquiries from WRC staff and Member organisations.

The library is part of the Technical Information Section which already makes extensive use of internal and external computer facilities, including production of the Aqualine database. There will be the opportunity to contribute to the development of a computerised library housekeeping system and other applications of information management.

The successful applicant will have the ability to communicate with staff and management within the Centre and also to project a modern image for the technical library in WRC and outside.

Salary will be in the range £6804 p.a. to £9033 p.a. and benefits are those normally associated with a progressive organisation.

Write to the Personnel Department, Water Research Centre, Medmenham Laboratory, PO Box 16. Marlow, Bucks., SL7 2HD. Tel: 049-166-531 for an application form quoting Post No. 96 to be returned by 2 March 1984.

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The main current interest is in multiphase flow problems such as transient gas-liquid flows in pipelines, although the successful candidate would be expected to apply fluid flow expertise to a wide range of topic areas.

Candidates with a good honours degree in mathematics or a related subject, should have at least ten years experience in the numerical solution of fluid dynamics problems, or relevant post doctoral research.

An attractive remuneration package includes non-contributory pension scheme, subsidised restaurant, on-site sports and social facilities and relocation assistance, where appropriate.

Please write, quoting reference SR 5572 to:- Anne Handry, The British Petroleum Company plc, BP Research Centre, Chertsey Rd., Sunbury-on-Thames, Middx. TW16 7LN.

BP Research
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Applicants should hold the Ordinary Tec Certificate in appropriate subjects or an equivalent of higher qualification, and have good practical experience in the design of electronic circuits using state-of-the-art techniques. Quote ref 0758.

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The department is well equipped and is actively engaged in collaborative research developing electronic and microcomputer applications in Psychology and Psychiatry.

The post is one of three and the salary scale will depend on the applicants qualifications and experience. Quote ref 1721.

Application form and job description available from the Personnel Dept., Royal Free Hospital, Pond Street, Hampstead NW3.

Tel (01) 794 0500 ext 4286.

Closing date 9 March, 1984

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Department of Chemistry

POSTDOCTORAL and POSTGRADUATE RESEARCH ASSISTANTS

required for MRC-funded posts to work on various projects on protein engineering and DNA replication under the supervision of Professor A. R. Fersht, FRS. One postdoctoral position is available immediately, the other two to start in September 1984. Work will involve protein chemistry and enzyme kinetics, gene cloning and mutation and oligodeoxynucleotide synthesis.

Salary scale: £8376–£10 611 for postdoctoral position and £7496–£9716 for postgraduate, inclusive of London Allowance.

Applications (full curriculum vitae and names of two referees) to be sent to Professor A. R. Fersht, Department of Chemistry, Imperial College, London SW7 2AY.

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Candidates should have an HNC or equivalent in Chemistry and will have two-three years' experience in an industrial analytical laboratory.

In addition the person appointed must be able to work with the minimum of supervision; travelling to off-site work will be required. A clean current driving licence is therefore essential.

Starting salary will be in the range of £6854 to £8802 pa and dependent upon age and experience. We are offering 22 days holiday pa and other benefits associated with a large company.

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Curator of Birds or Mammals, (one position) Position No: AUS 83/11. Wage: A$17 110 range A$37 751. Subject to certain conditions, successful applicants may be eligible for reclassification as research scientist/senior research scientist/principal research scientist, with progression to A$39 051. Qualification: Essential—University degree in zoology with research experience in an appropriate field. Applicants should have some knowledge of modern museum curatorial practice. Research interests should be orientated towards work which involves the use of the collections, with research on systematics (especially at supra-specific levels), evolutionary biology and biogeography preferred. A wide knowledge of mammalian or avian biology is essential and is more important than a thorough knowledge of Australian Mammals or Birds. Duties: To curate the mammal or bird collections and to be responsible for the answering of public and professional scientific enquiries. To participate in the museum's display and educational programmes in the appointee's field of study, and to carry out an active programme of research in some field of Australian mammalogy or ornithology. Conditions: Subject to certain conditions, the successful-applicant will be eligible for: Payment of fares to Sydney, Financial assistance towards cost of removal expenses, and Financial assistance towards initial accommodation expenses.

Enquiries: Tel (02) 339-8111 (Dr Cogger). Applications are to be sent to the Staff Clerk, The Australian Museum, 6-8 College Street, Sydney 2001, by 10 April, 1984.

UNIVERSITY OF LONDON
Institute of Psychiatry
DEPARTMENT OF BIOCHEMISTRY

MLSO required from 1 April, 1984 to work on the effects of cholinergic agonists on presynaptic phosphatidylinositol metabolism and intraterminal free calcium levels. Previous experience in neurochemistry, particularly techniques involving lipids, would be a considerable advantage.

The post is grant-supported for three years. The appointment will be for one year in the first instance.

Whitley Council Salary and conditions of service (£5491-£7747 pa plus £1042 pa London Weighting).

For application form, send stamped addressed envelope to the Assistant Secretary, Institute of Phychiartry, De Crespigny Park, Denmark Hill, London SE5 8AF quoting ref MB/NS. Closing date for applications: 7 March, 1984.

University of Oxford in association with Worcester College

UNIVERSITY LECTURERSHIP IN PHARMACOLOGY

Applications are invited for the above post. Stipend according to age on the scale £7190 to £15 085. The successful candidate may be offered a stipendiary Tutorial Fellowship by Worcester College. Details from: Sir William Paton, Department of Pharmacology, South Parks Road, Oxford OX1 3QT, to whom applications (nine typed copies, two for overseas applicants) with the names of three referees should be sent by 30 April, 1984.

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The Company offers excellent salaries, 23 days holiday, contributory pension fund, health insurance scheme, subsidised cafeteria, recreation club and pleasant offices in an attractive location.

Please apply to Rod Cook, Assistant Personnel Manager, Searle Research & Development, Lane End Road, High Wycombe, Bucks (Tel: High Wycombe 21124, ext 3372).
Please Quote reference QA01.

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If you can combine a degree in Chemistry, and some knowledge of Biology with about 1-2 years' analytical chemistry experience, contact Peter Silvester, Senior Personnel Officer, Ciba-Geigy Pharmaceuticals Division, Hurdsfield Industrial Estate, Macclesfield, Cheshire SK10 2LY, or telephone for an application form on Macclesfield (0625) 21933 ext 352.

CIBA–GEIGY

POSTDOCTORAL FELLOWSHIP IN ANALYTICAL CHEMISTRY

Applications are invited for a two year Postdoctoral Research post sponsored by the Ministry of Agriculture, Fisheries and Food in collaboration with Dr L. Ebdon and tenable from 1 April, 1984. The experimental work will be primarily based at the Food Science Laboratory, Norwich using ICP-MS for trace element determinations and coupled HPLC-ICP-MS for trace metal speciation in food. The starting salary will be £7659.

Further particulars and application forms to be returned by Friday 2 March, 1984, may be obtained from the Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth, PL4 8AA. Tel: Plymouth (0752) 264639.

Plymouth Polytechnic

Senior Research Scientist

Allied Breweries Limited, the beer division of Allied-Lyons PLC is a major Company within the drinks industry engaged in the production, distribution and retailing of beer, which includes such leading brands as Double Diamond, Skol, Long Life and Lowenbrau and a wide range of regional ales.

A Senior Research Scientist is required for the Research and Development Laboratory to carry out and supervise research projects concerned with the technologies of beer and other beverage production. Duties will include the assessment and introduction of new analytical instrumentation and the development of new instrumental methods of analysis.

Applicants should possess a good honours degree in chemistry with extensive experience of instrumental techniques. A research degree and/or statistical and computing experience, would be advantageous.

An attractive salary will be offered together with other benefits normally associated with a large company. The position is based in Burton-on-Trent and assistance with relocation expenses will be offered where appropriate.

**Application forms should be obtained from the following address:- Mrs. C. M. Lane,
Personnel Officer (Central Staff),
Allied Breweries Limited,
107 Station Street,
Burton-on-Trent, DE14 1BZ.**

ALLIED BREWERIES LIMITED

ADAS

Agriculture Service

AGRICULTURAL SPECIALISTS

Wide-ranging opportunities of vital national importance

The main aim of the Agriculture Service of ADAS is to increase productivity in the farming industry. This is achieved by the provision of technical and economic information and advice on agricultural and horticultural production and by promoting the results of investigational and development work undertaken by the Service. The monitoring of current trends in the industry and the provision of accurate information on the farming scene is an important supplementary function. Vacancies for Advisory Officers exist in various parts of England and Wales in the following disciplines:

AGRICULTURAL ENGINEERING

You will provide advice to farmers and growers on all aspects of mechanisation and encourage the adoption of methods leading to greater productivity. There are opportunities for specialisation and for some research and development work.

AGRICULTURE

As an Agricultural Advisory Officer, located in one of the Ministry's Divisional or Area Offices, you will be in close touch with farmers. You will provide advice, promote new technology and carry out investigational studies leading to improved farm practice. Other responsibilities include writing technical articles for the Press and other publications, organising promotional events and technical administration of certain statutory schemes.

DAIRY HUSBANDRY

The work involves technical supervision of the production and handling of milk on farms under the Milk and Dairy Regulations. In addition, you would advise dairy farmers on many aspects of husbandry and technology of milk production. Promoting new techniques and management systems will be important aspects of your work. Identifying factors which limit productivity and innovations in husbandry practice provides opportunities for involvement in investigational and development projects.

HORTICULTURE

Horticultural Advisory Officers advise producers of horticultural crops, covering fruit, vegetable, glasshouse, hardy ornamental and bulb flower crops. You would take a special interest in the types of horticulture within your area and in related experimental and development work conducted at experimental horticulture stations. There are also opportunities for appointment to these experimental stations.

LIVESTOCK HUSBANDRY

You will specialise to some extent in dairy cattle, beef cattle, sheep or pig production. The work includes advising farmers on livestock husbandry, participating in research and development and encouraging the adoption of new and improved technology. In addition the Livestock Group has a responsibility of advising on the effective selection, testing, evaluation and use of AI sires

POULTRY HUSBANDRY

You will advise the poultry industry on good husbandry and efficient production. This involves advisory visits to farms, preparing technical leaflets and local press articles, and group discussion meetings. Officers in this field also take an active part in development work.

SALARY AND QUALIFICATIONS

You may be appointed to one of two grades depending on your qualifications and experience: for appointment to Grade IV (£5680-£7765) you must have, or obtain in 1984, a degree or equivalent in a relevant subject. For appointment to Grade III (£7325-£11,475) you should normally have a relevant degree with at least 3 years' appropriate postgraduate experience.

A full valid UK driving licence is essential

FINAL YEAR STUDENTS MAY APPLY.

For further details and an application form (to be returned by 2 March 1984) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Please quote ref: S(A)906.

Ministry of Agriculture, Fisheries and Food

UNIVERSITY OF BIRMINGHAM
Faculty of Medicine and Dentistry
CLINICAL GENETICS

A vacancy has arisen in the above department for a research associate to work on cytogenetic aspects of mental retardation.

Salary–Research associate 1B £6310-8530 (plus superannuation) for two years.

Further information from Assistant Registrar, The Medical School, Birmingham B15 2TJ, To whom applications (three copies) must be sent by 9 March, 1984. Quote Ref RA/CG/TW.

TEMPORARY RESEARCH TECHNICIAN GRADE 5

Applications are invited for this post to work on enzyme activity in field crops. The work is based at the University farm at Bramham where accommodation may be available. The appointment is for 10 months starting 1 March or as soon as possible thereafter at a salary of £6279 pa. Applicants should have HNC or a Degree and relevant experience. Apply to Professor J. Elston, Department of Plant Sciences, Agricultural Sciences Building, Leeds University LS2 9JT.

RESEARCH TECHNICIAN required in the Rheumatology & Allergy Research Unit, Birmingham University to assist in work involving the synthesis of peptides of immunological interest.

Applicants must possess high level qualifications in a Biological Science plus experience in protein chemistry. Salary scale £5151-£6035 pa.

Application form from Assistant Secretary, Personnel Office, University of Birmingham, PO Box 363, Birmingham B15 2TT. Ref: 407/C/87.

ROTHAMSTED EXPERIMENTAL STATION
Harpenden, Herts AL5 2JQ
SCIENTIFIC OFFICER/HIGHER SCIENTIFIC OFFICER – MOLECULAR BIOLOGIST

Applications are invited for a Scientific Officer/Higher Scientific Officer to join a team in the Biochemistry Department involved in the isolation and transfer of plant genes between crop plant species. The work will involve the characterisation of cDNA and genomic clones and ultimately the study of the expression of transferred genes. The person appointed is likely to be a graduate in Biochemistry or a related subject and with practical experience in some aspects of recombinant DNA technology. The work is funded by the EEC and involves collaborative work with other European laboratories. The appointment is from 1 May, or as soon as possible thereafter, for a period up to March 1986.

Qualifications: First or upper second class honours degree in Biochemistry or related subject with at least two years relevant post-qualifying experience for HSO.

Appointment in grade of Scientific Officer (£5682-£7765) or Higher Scientific Officer (£7149-£9561). Non-contributory superannuation.

Apply in writing to the Secretary giving names and addresses of two referees and quoting Ref: 548 by 9 March 1984. Further details on request.

THE UNIVERSITY OF LEEDS
PROCTER DEPARTMENT OF FOOD SCIENCE
LECTURER

Applications are invited from Biochemists or Chemists for the above post. The successful applicant will be required to develop an interest in meat science and in modern developments in the processing of animal products.

Salary on the scale for Lecturers (£7190-£14 125) according to age, qualifications and experience.

Informal enquiries should be made to Professor David S. Robinson, telephone (0532) 431751, extension 540.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference no 72/17/E, to whom applications should be addressed.

Closing date for applications 8 March, 1984.

THE LONDON HOSPITAL MEDICAL COLLEGE
(University of London)
PART-TIME JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

Part-time JLSO required immediately to work for the Departments of Urology and Biochemistry in the subject of biochemistry of male infertility. Science "A" levels or HNC essential.

17½ hours per week (by arrangement) for one year in the first instance.

Salary pro rata within the JLSO (B) range £4498-£5860 inclusive of London Weighting.

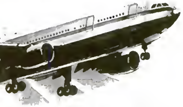
Applications in writing to the College Secretary, Mr D. L. Edwards, The London Hospital Medical College, Turner Street, London E1 2AD from whom further details of the post may be obtained (Tel 01-377-8800 Ext 12).

Closing date: within 14 days of the appearance of this advertisment.

COMPOSITES DESIGN ENGINEERS

U.S.A AEROSPACE $30-50,000

A leading American corporation with considerable investment in the aerospace and gas turbine industries has a number of opportunities for experienced Composite Design Engineers within one of their advanced engineering facilities.



They are principally interested in meeting Design Engineers with a minimum of 2·5 years experience in the design and analysis of sophisticated composite structures or components using advanced composite materials. Any additional experience in the development and specification of manufacturing processes would also be useful.

Successful candidates will assume challenging assignments in an expanding technology department whose task is to design components for use in aircraft engines and structures which can operate to exacting standards both in terms of mechanical and thermal stress, and vibration characteristics whilst achieving realistic manufacturing costs.

All candidates must possess a BSc or equivalent plus related experience.

Our client offers a wide range of benefits including medical and dental insurance for you and your family. Full assistance with visas and relocation will be provided.

If you are interested in discussing these career opportunities and living in an attractive part of the United States then contact Colin Hush on 01-938 1804 during office hours up to 7 p.m. or alternatively write to IPP International, 20 Kensington Church Street, London W8 4EP.

SPECIALIST RECRUITMENT CONSULTANTS

IPP International

20 Kensington Church Street, London W8 4EP Tel: 938 1804 Telex: 22861

UNIVERSITY OF OXFORD

Inorganic Chemistry Laboratory and Exeter College

DEPARTMENTAL DEMONSTRATORSHIP AND FELLOWSHIP IN CHEMISTRY

Applications are invited from graduates in Chemistry for a Departmental Demonstratorship in Inorganic Chemistry which may be held in conjunction with a Fellowship in Chemistry at Exeter College. Both posts would be tenable for three years in the first instance and renewable up to a maximum of six years tenure. Both posts are open to both men and women.

The Departmental salary would be according to age and experience within the range £6310 to £8975 pa. The College post carries a stipend of £1960 pa, with certain other allowances.

The person appointed will be expected to pursue his/her own research interests, to supervise research students and to take such part in the teaching and administration of the department both in term and vacation as may be required by the Professor of Inorganic Chemistry. The College will require up to five hours teaching a week in Inorganic Chemistry for undergraduates taking the Honour School of Chemistry. Further details of the College appointment may be had from the Senior Tutor, Exeter College, Oxford.

It is hoped to make an appointment with effect from 1 October, 1984. A single application for the two posts with curriculum vitae, a statement of research interests and the names of two referees, should be sent to The Administrator, Inorganic Chemistry Laboratory, South Parks Road, Oxford OX1 3QR, before 16 April, 1984.

Toxicol

TOXICOLOGIST

An energitic, innovative person is required to fill a vacancy in the expanding Chronic Toxicology Department of Toxicol Laboratories Limited, an international company specialising in contract research. The ideal person should have graduate or similar qualifications in a relevant biological subject. Some knowledge of pharmacology, metabolism and biochemistry would aid candidate selection.

Please telephone for an application form to:

Miss C. C. Smillie,
Toxicol Laboratories Limited,
Bromyard Road,
Ledbury,
Herefordshire.
HR8 1LG.

Telephone: Ledbury (0531) 4121.

UNIVERSITY OF SURREY

Department of Mechanical Engineering

LECTURER IN BIOMEDICAL ENGINEERING

The recently restructured Biomedical Engineering Group is seeking applications from graduates with qualifications or experience in some branch of Biomedical Engineering or related discipline.

The successful candidate will be required to contribute to postgraduate course teaching and to participate in and initiate research in Biomedical Engineering. The Department itself has extensive mechanical and instrumentation resources and opportunities are presented for undergraduates teaching in mechanical engineering courses.

He/she will be expected to share administrative duties and will have an opportunity to influence the development of the group, the reorganisation of its resources, and formation of links with local health care units and with University Life Science Groups.

Applicants should be aged 25+ with a pleasant personality and be willing to collaborate with colleagues in a range of engineering/life science disciplines.

Salary is in the range of £7190 to £14 125 with Superannuation under USS conditions.

Further particulars are available from the Academic Registar (LFG), University of Surrey, Guildford, Surrey, GU2 5HX, or Tel Guildford 571261 Ext 633. Applications from men and women, in the form of a curriculum vitae, including the names and addresses of three referees, should be sent to the same address by 16 March, 1984 quoting reference 239/NS.

Pharmacist for Medical Information Work

An interesting opportunity has arisen for a qualified Pharmacist to join the small medical information team which supports ICI Pharmaceuticals Division's UK sales force.

Our ideal candidate would be a Pharmacist who has already had experience of information work within the industry but we would be happy to hear from qualified Pharmacists with 2 or 3 years hospital experience who have an interest in information work and could work successfully in a commercially sensitive environment. The work demands high technical competence, initiative and enterprise and is an ideal introduction for a pharmacist who is looking for a route into a commercial organisation.

Medical Information Officers operate over a wide ranging field within ICI Pharmaceuticals Division's International business and therefore career prospects are good within the information field, with wider prospects of moves into marketing and other functions for suitably experienced people.

Starting salary would be in the region of £11,000 with prospects to reach £13,500 in a relatively short time. Additional bonuses make up a very attractive remuneration package and the remaining conditions of employment are equally competitive.

For application form contact:

Mrs J M Maynard,
Personnel Officer,
Imperial Chemical Industries Plc,
Pharmaceuticals Division,
Alderley House,
Alderley Park,
Macclesfield,
Cheshire, SK10 4TF.
Tel: (0625) 582828 ext 230

HONOURS GRADUATES

"The truth is rarely pure and never simple." Oscar Wilde

Discerning fact from fiction is never an easy job. Tax Inspectors have to use perception and persistence to unravel the complexities of business accounts and identify any irregularities.

Through intensive training you will develop the skills of a lawyer, advocate, accountant, investigator, negotiator and manager. You will become capable of examining the accounts of businesses ranging from small shops through to £multi-million organisations, agreeing their tax liabilities, detecting fraud, and negotiating settlements with taxpayers and their financial advisers.

Within a few months you can expect to be handling your own casework, involving many face to face interviews. After 3 years you will be managing a sizeable team of staff and, in due course, you should be running your own tax district.

Qualifications: Under 32 and a degree with at least second class honours or an acceptable equivalent qualification. Final Year Students may apply.

Starting salary £5785-£7980 according to experience. You should be earning £8780 after 2 years and £12395 3 years later. Within 11 years you could be on a salary scale rising to £20790. In another 5 years you could be on a scale rising to £23155. Beyond this there are opportunities for further promotion to the most senior grades in the Civil Service. SALARIES HIGHER IN LONDON. Training can usually begin at an office in the area of your choice.

To find out more and for an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).
Please quote ref: A/320/172.

UNIVERSITY OF SURREY
Department of Biochemistry

LECTURER IN NUTRITION AND DIETETICS

Applications are invited for the post of Lecturer in Nutrition and Dietetics in the Division of Nutrition and Food Science in the Biochemistry Department.

The person appointed will be expected to teach nutrition and dietetics on the honours degree courses and to actively pursue relevant research work. In addition, it is expected that he or she will participate in the dietetic service in the Guildford and District hospitals.

Applicants must have an honours degree and a higher degree in nutrition and also State Registration in Dietetics. Salary will be on the University Lecturer Range (£7190-£14 125) depending on age, qualifications and experience.

Further particulars are available from the Academic Registrar (LFG), University of Surrey, Guildford, Surrey GU2 5XH, or Tel Guildford 571281 Ext 633. Applications from men and women, in the form of a cv, including the names and addresses of three referees, should be sent to the same address by 9 March, 1984 quoting reference 236/NS.

METOCEAN
Consultancy Limited

This young company requires additional personnel to provide consultancy and project management in marine site investigations for the oil and civil engineering industries, with particular reference to the metocean sciences.

The successful applicants will have qualifications in either oceanography, hydrography or ocean engineering and significant experience of work in the commercial sector.

These are senior posts with the potential to play a substantial role in Metocean's development. They carry the appropriate incentives and remuneration. Apply in confidence with curriculum vitae and references to:

The Managing Director,
Metocean Consultancy Ltd,
Grove House,
Grayshott,
Surrey GU26 6LE.

SCIENCE AND TECHNOLOGY
(University of London)

HIGH INTENSITY COMBUSTION RESEARCH

Applications are invited for a research post at Graduate level on a SERC funded project involving a combined experimental and computational study of swirl stabilised high intensity combustion systems. Applicants should have an Honours degree in Engineering or Physics and an interest in fluid mechanics, combustion and measurement techniques.

The successful candidate will have the opportunity to register for the degree of PhD. Salary will be dependent on age and experience and in accordance with the IB University scales plus London Allowance.

Applications, including a cv and the names of two referees, to Dr W. P. Jones, Department of Chemical Engineering and Chemical Technology, Imperial College, London SW7 2BY as soon as possible.

Synthetic Organic Chemists For Drug Discovery

In the middle of 1984, as part of a major expansion programme, we shall be opening an additional 70,000 sq ft of laboratory and office space at our research centre at Sandwich, Kent. This will enable us to increase our commitment to human drug research, especially in the cardiovascular area.

We are looking for:

A Project Leader

to take charge of one of our cardiovascular projects.

Our need is for a synthetic organic chemist with 6/10 years' post-doctoral experience, mainly in the drug industry. He/she will probably be leading a small team already and seeking to broaden his/her responsibilities as a scientist. Experience in the cardiovascular area would be preferable but not essential.

Three Post-Doctoral Chemists

with experience in synthetic organic chemistry coupled with a desire to discover drugs. Close collaboration with biological colleagues is essential in our multi-disciplinary project teams.

Our need here is for one chemist with 3/5 years' research experience in the pharmaceutical or agricultural/veterinary industry and two chemists who are completing 2/3 years' post-doctoral research.

Graduate/GRSC/LRSC Chemists

We need several young, energetic chemists experienced in modern methods to synthesise novel molecules for biological evaluation. Our laboratories are modern and well equipped with up-to-date instrumentation and support services.

All our chemists have ready access to the Research Division computers and molecular graphic techniques are used regularly to aid the design of biologically active molecules.

Pfizer

If you have the necessary qualifications and experience and want to further your career in drug discovery please send your cv to:

D. W. Sells, Personnel Manager,
Pfizer Central Research,
Ramsgate Road
Sandwich
Kent CT13 9NJ

If you have applied for a similar position with us in the past two years your previous application will be considered automatically; there is no need to reapply. All applications will be treated in strict confidence.

1979

Laboratory Technician

c£6,000p.a.

Bush Boake Allen Ltd is one of the world's major producers of flavours and fragrances. With over 100 years experience in this specialised field it has established an international reputation and a commanding position in the UK and overseas.

Due to internal promotion we require a Laboratory Technician, male or female, to work in our fragrance Application Laboratory to be based at our Headquarters in Walthamstow, London. Responsible to a Product Specialist, who is working on a wide range of consumer products, the Technician must be able to work with minimum supervision. The job will involve product formulation, understanding the role of the perfume in the system, and measuring its performance and effect under in-use conditions.

Work experience in a chemical laboratory or a pharmacy is desirable.

Education indicator, HNC or TEC Higher Cert level in Chemistry or equivalent qualification in Pharmacy.

Benefits include free life assurance, non-contributory pension scheme.

Please apply in writing to Recruitment Manager, Bush Boake Allen Ltd, Blackhorse Lane, Walthamstow, London E17 5QP

Bush Boake Allen Ltd.

Physical Chemist

Skin Care Research

A vacancy has arisen in an active research group investigating the efficacy and mode of action of skin care materials. The overall objective is to indentify and develop new methods of maintaining and improving skin condition.

A scientist is required to examine and advise on the parameters controlling the penetration of active ingredients into the skin from emulsion systems. Absorption of substances onto keratin will also be included as will systemic penetration.

Close liaison with colleagues with product efficacy and those specialising in formulation of new products will be an important aspect of the job.

The vacancy will probably suit a chemistry graduate with several years experience in physical chemistry and an interest in applying this expertise to biological systems.

Conditions of employment include flexible working hours, 22 days annual holiday and a non-contributory pension scheme.

Please apply in writing, enclosing curriculum vitae and stating salary expectations to: Miss E. M. Holland, Personnel Manager, Beecham Products Research Department, St George's Avenue, Weybridge, Surrey KT13 0DE

Beecham Products B

Senior Research Chemist

Pangbourne, Berkshire; £10-£14,000

Castrol Research Laboratories employ around 170 people mainly comprising chemists, engineers and business professionals and is Castrol's main centre for its lubricants research and development. It is part of the Burmah Group which is active in oil exploration and production, fuels, shipping, speciality chemicals and retailing and distribution.

A new position has been created for a Senior Research Chemist who will have a PhD and between 2 to 5 years' post-doctorate experience, and will be aged about 30 years. Only exceptional candidates without a PhD will be considered for interview.

The Company is especially interested in people whose PhDs have been obtained in one or more of the following areas: surface chemistry relating to corrosion and/or wear and friction; polymer chemistry relating to the properties of polymers in solution; chemistry of natural products.

The key tasks in the post will be to direct small teams of other scientists on projects in one of a number of specialist fields of research. These teams will either be working in conjunction with universities, or with other research establishments.

In addition to academic qualifications, candidates must be able to demonstrate a high degree of competency in both written and spoken English, and be able to communicate with professional colleagues at all levels. A facility for dealing with senior staff on the commercial side of the Company will be an essential attribute. The post is based at Pangbourne but there will be some travelling.

The salary range is £10,000-£14,000 depending on experience, and there is an excellent benefits package including non-contributory pension plan, free life assurance and relocation assistance if appropriate.

Please send a detailed c.v. together with a synopsis of your PhD thesis, or telephone for an application form to: Liz Patterson,
Recruitment, Burmah-Castrol (UK) Ltd., Burmah House,
Pipers Way, Swindon, Wiltshire SN3 1RE.
Tel: Swindon (0793) 30151, extension 2984.

Burmah Castrol

UNIVERSITY OF CAMBRIDGE

University Lecturer in the Department of Physiology

Applications are invited for a University Lectureship, the appointment to commence on 1 October, 1984. Candidates should hold a PhD degree in some area of Physiology, or a medical or Veterinary qualification together with some experience of physiological research.

The appointment will be for three years, with the possibility of reappointment to the retiring age.

The pensionable scale of stipends, for persons not ordinarily resident in college, is £9875 a year, rising by eleven annual increments to £15,085. There is no grade of Senior Lecturer.

Further information about the duties and conditions of the appointment may be obtained from the Secretary of the Appointments Committee for the Faculty of Biology 'B', 19 Trumpington Street, Cambridge CB2 1QA, to whom applications (12 copies), including a curriculum vitae, list of publications and the names of not more than three referees, should be sent so as to reach him not later than 1 April, 1984. A candidate resident overseas may submit only one copy of an application.

BULLETIN EDITOR/ COMPILER

Initial salary £6000-£7000

We require a life sciences graduate aged up to 30, preferably with some knowledge of French and German, to work as a bulletin editor/compiler. Your duties will involve preparation and proofreading of abstracts, and their indexing and compilation to form bulletins for regular despatch to clients. Applicants must be able to work independently and in an organised manner so as to ensure that monthly deadlines are met.

Benefits include free BUPA.

Write to: Mr S. J. Lodge, Woolcott & Co Ltd, Chansitor House, 37-38 Chancery Lane, London WC2A 1EL

DURHAM UNIVERSITY

SENIOR RESEARCH ASSISTANT IN SYNCHROTRON RADIATION RESEARCH

Applications are invited for the post of Senior Research Assistant tenable in the Physics Department for two years from early 1984. The successful applicant will work, under the supervision of Dr B. K. Tanner, on an SERC supported project to develop X-ray diffraction techniques for the characterisation of strains in III-V semiconductors. Part of the work will be carried out on the Synchrotron Radiation Source at Daresbury Laboratory.

Initial salary in the range £7630-£8530 on National Range 1A plus superannuation.

Applications (three copies) naming three referees should be sent by 2 March, 1984 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

JAMES ALLEN'S GIRLS' SCHOOL

East Dulwich Grove, London, SE22 8TE

Required for September a well-qualified person of enterprise and experience to design, organise and set up computer science courses from the Third Form through to 'A' Level. Excellent facilities available which have up to the present been only on a well-established club basis.

Ability to teach Mathematics (or possibly another subject) preferably to Oxbridge standard would be desirable and a willingness to join in extra curricular activities a distinct recommendation.

A Scale 3 post on the JAGS Salary Scale (Burnham plus) with Inner London addition (at present £1220) available for an enthusiastic applicant interested in exploring the educational potential of computers and able to advise/assist colleagues in other departments.

Apply to the Headmaster giving a full curriculum vitae and the names and addresses (and telephone numbers if possible) of two referees.

UNIVERSITY OF LONDON

Imperial College of Science and Technology

Mineral Industry Chair of Mining Geology

R S M

The Senate invite applications for the Mineral Industry Chair of Mining Geology tenable at Imperial College of Science and Technology.

The Professor appointed will take charge of teaching and research in mining exploration geology and provide leadership in developing the applications of geology to the minerals industry. This Chair is financed by a group of mining companies and the incumbent will be expected to liaise effectively with the minerals industry.

Applications (ten copies) must be received not later than 31 May, 1984 by the Academic Registrar (NS), University of London, Senate House, London WC1E 7HU, from whom further particulars should first be obtained.

Ethical Pharmaceuticals

Director of Research

S E England Not less than £30,000 + car etc

My client is a profitable, sizeable and autonomous subsidiary of one of the world's most prestigious drug companies. In the UK it is engaged in the research, manufacture and marketing of a wide range of ethical pharmaceuticals.

It now wishes to appoint a new Director of Research, who will earn and use the support of a young, energetic and interested Board and prove worthy of appointment to it. Reporting to the Managing Director, the Director of Research will have full responsibility for the considerable Research Function, its enviable facilities and more than 200 staff.

The highest academic research record is vital; skills in leadership, management and development of the research teams must combine with a wholehearted and effective input to this multinational's research operations worldwide for the discovery of drugs that are medically valuable and commercially viable.

If you are interested in the very real challenge and rewards (salary will not be a limiting factor) of this job, write or phone me, Mrs. Indira Brown, Corporate Resourcing Group Ltd., 6 Westminster Palace Gardens, Artillery Row, London SW1P 1RL. Telephone: 01-222 5555. As an independent consultant, I shall treat your enquiry with complete discretion.

Corporate Resourcing Group

Management Consultants. Executive Search

Part of Berndtson International

BRUSSELS·COPENHAGEN·FRANKFURT·GENEVA·LONDON·MADRID·NEW YORK·PARIS

UNIVERSITY OF EDINBURGH

Department of Community Medicine

Research Associate

A research associate is required for a three-year investigation of mortality patterns in Scottish communities close to areas where shale was mined and extracted before 1962. The collaborative study with the Institute of Occupational Medicine is part of a larger project aimed at identifying occupational and environmental health hazards that may be associated with the shale industry. A one-year associateship is available immediately and may be renewable for a further two years as funds permit. The successful candidate is likely to have at least a first degree in one of the social sciences or statistics and will have experience or a special interest in demography and statistics.

Further particulars are available from the Secretary to the University, University of Edinburgh, Old College, South Bridge, Edinburgh EH8 9YL, with whom applications (6 copies) including curriculum vitae and the names of two referees, should be lodged not later than 1 March, 1984.

Please quote reference no 5148.

UNIVERSITY OF OXFORD
DEPARTMENT OF ENGINEERING SCIENCE

RESEARCH ASSISTANT

Physicists and Electronic/Electrical Engineers possessing a PhD or equivalent research experience are invited to apply for a Research Assistant post, in the salary range £8080 to £9425, lasting at least three years. The work is part of a broadly based research programme into device aspects of information processing. It provides scope for both theoretical and experimental work on novel solid state devices using surface and bulk acoustic waves and/or EM waves.

Applications, together with curriculum vitae and the names of two referees, should be sent to Professor E. G. S. Paige, University of Oxford, Department of Engineering Science, Parks Road, Oxford OX1 3PJ. Write for further information or ring Oxford (0865) 59988 Ext 461.

ELECTRO MEDICAL DEVELOPMENT ENGINEER

Surrey

If you are an experienced Engineer with a flair for co-ordinating projects and you are looking for the chance to really demonstrate your ability, this could be your opportunity to develop your career with one of the leading names in the healthcare industry. Working as part of a small but committed team your main aim will be to develop and co-ordinate development project programmes, meeting tight cost and time targets.

In addition to an HNC qualification (or equivalent) you should have proven experience within a medical/hospital/ healthcare environment with some knowledge of electronic/ electrical design and production. Familiarity with BS 5724/4199 would be useful.

The salary will be negotiable around £9,000 and the position carries with it the usual benefits associated with a successful company.

Please apply with full c.v. to:

R. Kilpatrick,
Senior Personnel Officer,
Downs Surgical PLC,
Church Path, Church Road,
Mitcham,
Surrey CR4 3UE.

DOWNS

MEDICAL RESEARCH COUNCIL
Radiobiology Unit, Harwell

SHORT TERM SCIENTIFIC APPOINTMENT

Applications are invited for a short term three year postdoctoral appointment to the Council's non-clinical scientific staff, to join a group studying the problems associated with the inhalation of radioactive particles. The work will include quantitative autoradiographic studies of lung tissue. Applicants with backgrounds in biological or physical sciences will be considered, computing experience would be useful.

Salary according to MRC scales (equivalent to those of non-clinical academic staff of UK universities). Hostel accommodation or temporary housing may be available.

For an application form and further information write or telephone to the Personnel Officer, MRC Radiobiology Unit, Harwell, Didcot, Oxon OX11 0RD. Telephone number 0235 834393. Names of two referees will be required but these will not be contacted prior to short-listing. Ref GP/STA/84.

Closing date 5 March, 1984

A Bigger Career Choice in Medical Sales

If you have a scientific or paramedical background and want to succeed in a commercial environment leading to a managerial role, then phone Andree Osborne or Alistair Ross now on 01-222 1547.

Ross Warren Recruitment

UNDERSEA EXPLORATION AND COMMUNICATIONS

We are retained by the Defence Systems Division of a major U.K., electronics company with special expertise in underwater telecommunications. As part of a major expansion programme they now seek to reinforce their management team with the following professionals:

Section Head – Array Systems & Sensors To £18,000 + car

Reporting to the Manager of Maritime Systems, you will be responsible for the design and development of major array systems, the control of customer funded R & D programmes, as well as the management of a team of senior engineers and projects leaders.
The successful candidate will be aged between 34–45 with an Honours degree in either electronics or physics, will have strong management capabilities coupled with communication skills, as well as experience within optical acoustic and electronics transmission systems and devices.

Principal Engineer – Sonar Systems Design. To £16,500

Reporting to the Manager of Maritime Systems Design, you will be a leader in the field of sonar engineering and underwater acoustics. The job's main function will be to act in a consultancy role, giving technical guidance to the management, marketing and contract administration, within all aspects of the design and development of the next generation of acoustic arrays and seismic streamers, for both commercial and MOD users.
The successful candidate will be aged between 35–45 and be qualified to degree standard in either physics or electronics. You will be a good communicator and have broad experience in sonar and underwater acoustics.
A comprehensive remuneration package is offered including generous relocation assistance to their attractive location in South East England.
For more information contact:
Tim Hallett or Simon Bretherton at the address below:

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PUBLIC HEALTH LABORATORY SERVICE BOARD

PHLS Centre for Applied Microbiology and Research

Microbial Technology Laboratory

A POST-GRADUATE BIOCHEMIST

is required to evaluate novel support matrices for the large scale affinity chromatography of proteins. This post is sponsored by the Engineering Sciences Division of AERE Harwell under the auspices of the BIOSEP project and is available for one year in the first instance. Applicants should have a PhD or an equivalent research qualification. Experience in the purification of proteins on a larger than normal laboratory scale and some understanding of the engineering aspects of large scale chromatography is desirable.

Appointments, subject to qualification and experience will be made on the post-probationary basic grade scale, £6520–£8349. NHS terms and conditions will apply. Applications with full curriculum vitae and the names and addresses of two professional or academic referees should be sent to: Mrs M. Bushby, Personnel Officer, PHLS Centre for Applied Microbiology and Research, Porton Down, Salisbury, Wiltshire SP4 0JG.

Candidates seeking further information should contact Dr M. Scawen on Idmiston (0908) 610391 Ext 220.

Closing date for applications will be 2 March 1984.

WELSH NATIONAL SCHOOL OF MEDICINE
(University of Wales)

DEPARTMENT OF SURGERY

POST-DOCTORAL RESEARCH OFFICER IN CELL BIOLOGY is required to work on a three-year project to establish the role of intracellular regulators in oxygen radical production by phagocytes and their importance in inflammatory diseases. Candidates should have a first degree in a relevant discipline and recently have obtained or submitted a thesis for a PhD. Previous research experience in cell separation, cell culture and fluorescence microscope techniques would be advantageous though not essential. Starting salary up to £7190 pa.
Further particulars (quoting ref. No. S19/2/67) are available from the Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff CF4 4XN to whom application in the form of a curriculum vitae with the names and addresses of two referees should be submitted by 19 March, 1984.

THE CAMPDEN FOOD PRESERVATION RESEARCH ASSOCIATION
Chipping Campden, Glos GL55 6LD

Applications are invited from science graduates who have specialised in Electron Microscopy to initiate and expand a new facility within the Research Association. The work will consist of providing initially a service to other scientists researching a range of topics such as metal surface problems, spore studies and investigations on food structure. The successful applicant will provide evidence of innovation, versatility and enthusiasm for what is regarded as a key appointment within the research team.

Qualifications: 1st or 2nd Class Honours in a scientific subject with postgraduate experience in microscopy. The salary will be appropriate to age, experience and qualifications.

For further particulars, contact Dr A. Robertson, Head of Chemistry and Biochemistry Department

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UNIVERSITY OF BRISTOL

DEPARTMENT OF PHYSICS

RESEARCH ASSISTANTSHIPS IN FIBROUS BIOPOLYMER RESEARCH

Applications are invited for *three* posts to undertake structural studies in fibrous biopolymers. The research will be supported by the Agricultural and Food Research Councils Link Group Scheme, on the basis of a collaboration between the University's Physics Department and the Council's Meat Research Institute. This project is part of an ongoing research programme concerned with structure and morphology of fibrous biopolymers, using X-ray diffraction, electron microscopy, Fourier transform infrared spectroscopy and biochemical analysis and characterisation.

Prospective candidates should have a PhD degree and experience in biophysics, biochemistry or materials science. The posts are tenable immediately and renewable for up to three years. Salary range £8530 to £9425 pa plus superannuation.

Applications by letter, with curriculum vitae and the names of two referees should be sent to Professor E. D. T. Atkins, H. H. Wills Physics Laboratory, Tyndall Avenue, University of Bristol, Bristol BS8 1TL, as soon as possible but no later than 29 February, 1984

BIO-RESEARCH LABORATORIES MONTREAL, CANADA

TOXICOLOGIST

Bio-Research Laboratories is an expanding and Internationally recognized biological contract research laboratory. We are involved in all aspects of safety evaluation of new drugs and chemicals. Over the past four years, our company has doubled in size to a staff of 275 who are housed a modern, fully equipped, 85 000 sq. ft. laboratory, situated in pleasant countryside 12 miles west of Montreal, Quebec.

Our division of Toxicology Operations seeks an experienced Toxicologist to be responsible for the organization, management and conduct of short and long term toxicity studies. The work also involves frequent interaction with sponsors from North America, Europe and Japan.
Candidates should possess a degree in a biological or related science (preferably to the PhD level) and have several years industrial experience in general and/or inhalation toxicology.

Salary and conditions are competitive with industry and dependent upon experience and qualifications. Relocation assistance will be provided.

Applications with CV should be sent to:

Dr B. E. Osborne,
Director, Division of Toxicology Operations,
Bio-Research Laboratories Limited,
87 Senneville Road,
Senneville, Quebec H9X 3R3
Canada

New European Technical Centre

Principal Development Scientist

the challenge of developing new materials for our expanding product range

c.£12,000 p.a.

Crawley, West Sussex

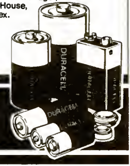
Duracell has achieved its position as world leader in the premium dry cell battery market through a continuing drive to improve product performance and develop new battery systems. Key to our continued growth is the applied scientific research and development work to be carried out at our new European Technical Centre in Crawley.

Major investments have been made in this new Centre and its people. Now in preparation for its opening this Spring we're looking for a Principal Development Scientist to lead a team involved in the development of materials and processes.

Aged 28 years +, you'll hold a good Honours Degree in Applied Chemistry, Materials Science or Metallurgy, together with at least 2 years' proven supervisory experience. Some experience of working in a computerised laboratory environment would be a distinct advantage.

You'll be working in a pressure environment with timescales to meet, but will be given the creative freedom to initiate fresh ideas and bring some entirely new thoughts to the development of a wide range of battery systems. In return, you'll enjoy a very competitive salary and a full range of large company benefits including generous relocation assistance where appropriate.

So, join us at the beginning of this exciting stage of development. Telephone for more details or write with full c.v. to Kevin Elvidge, Personnel Manager, Duracell Batteries Limited, Mallory House, Gatwick Road, Crawley, West Sussex. Tel: Crawley (0293) 26041.



DURACELL®

The European Molecular Biology Laboratory, a research institute situated in Heidelberg, West Germany, invites applicants for the following vacancy at the Laboratory's Outstation at the Deutsches Elektronensynchrotron (DESY) site in Hamburg.

BIOCHEMISTRY LABORATORY ASSISTANT

The Outstation at the storage ring DORIS is dedicated to the use of synchrotron radiation in biological structure research. The successful candidate will be responsible for maintaining the biochemical facilities used by visiting groups carrying out research projects at the Outstation for limited periods of time. Beside this, there is an opportunity to participate in a limited in-house project on assembly properties of components of the cytoskeleton or on the structure of chromatin.

Applicants should have an appropiate degree and advanced technical skills. A knowledge of more than one of the official languages of the Laboratory (English, French, German) would be an asset.

An above-average salary will be offered to the successful candidate. Certain allowances are payable in addition, depending on personal circumstances. An initial contract of three year's duration, which can be renewed, will be offered.

Please write briefly for an application form quoting reference N 83/43 to: EMBL, Personnel Section, Postfach 10.2209, D-6900 HEIDELBERG

Scientist

SW LONDON **up to £10,520**

We are looking for a young experimental scientist to join a group working on the experimental measurement and prediction of vapour liquid equilibria. The work will involve developing apparatus to measure phase equilibria at high pressures and both low and high temperatures. Experience in experimental work of this sort would be an advantage, but your level of ability is more important than specific experience. The post will involve close co-operation with work on predictive methods.

You should be up to 25 years old and have a good degree in Chemistry, Physics or Chemical Engineering, plus some experience. This post is an opportunity to join a lively group working in a friendly atmosphere where there are opportunities for advancement.

Starting salary will depend on qualifications and experience, but will be within the range £7,444 – £10,520 (including Inner London Weighting). Benefits are those normally associated with a large progressive organisation.

For further details and an application form, please contact The Personnel Officer (Fulham), British Gas, London Research Station, Michael Road, Fulham, London SW6 2AD, quoting reference LRS/244.

BRITISH GAS

Agricultural Scientist

ICI Plant Protection Division require an Agricultural Scientist to become an agronomic adviser and specialist in reduced and zero tillage. The person appointed will join the Product Application Group at Fernhurst and will work initially as an individual. He/she will interact with technical and marketing colleagues to initiate proposals for research, development or technical service work in support of ICI herbicides worldwide. This may lead to a programme of research into relevant problems and the job may develop into leading a small multidisciplinary team.

Advice on agronomic aspects of agrochemical application will also be involved. Essential qualifications are:

1. A higher degree in Agronomy or a related specialist discipline.
2. Ability to communicate and interact effectively with technical and marketing staff within ICI and with farmers, advisory workers and scientists in the UK and overseas.

Experience of research and/or overseas agriculture is desirable.

We can offer an attractive salary, and will help with relocation expenses where appropriate.

If you are interested in this post please send a detailed letter of application and a curriculum vitae to the address given below before 12 March, 1984.

Personnel Department, ICI Plant Protection Division,
Fernhurst, Haslemere, Surrey

Please quote reference number PPD990.

ICI

Plant Protection Division

UNIVERSITY OF EDINBURGH
Department of Molecular Biology

Post-Doctoral Research Fellow

Applications are invited for a post-doctoral research position to investigate the molecular structure and function of a novel transposable sequence found in wide host-range IncP plasmids.

Experience in molecular genetics or plasmid DNA manipulations is desirable. The appointment is available from 1 March, 1984 for one year and one month. Salary will be on Research Range 1A.

Applicants should send a CV, references and a letter describing their research interests to Prof N. S. Willets, Department of Molecular Biology, University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JR.

Please quote reference No 5147

BRUNEL UNIVERSITY
Department of Physics
POSTDOCTORAL RESEARCH FELLOW

A Research Fellow 1A is required, as soon as possible, to work with Professor C. A. Hogarth on a programme of Experimental research on thin polymer/metal films supported by the SERC under their special initiative on electroactive polymers. The grant is for a period of two years.

The starting salary for this appointment is £7190 pa, plus £1186 pa London Allowance, with USS benifits.

For an application form, please contact the Personnel Secretary, Brunel University, Uxbridge, Middlesex, UB8 3PH, or Tel Uxbridge 37188 Ext 49. Closing date 9 March 1984.

NEW SOUTH WALES GOVERNMENT DEPARTMENT OF AGRICULTURE

Special Livestock Officer

(Grazing Management) Cobar

Position No. Ag83/337

Equality of Employment Opportunity is Public Service Policy. Selection is based on efficiency as defined in Section 62 of the Public Service Act, 1979, and applications are invited regardless of sex, marital status, race, colour, nationality, ethnic or national origin, physical or intellectual impairment, or homosexuality.

SALARY: A$28 409 range A$30 119.

QUALIFICATIONS: *Essential*: Degree or Diploma in Rangeland Management, Agricultural, Rural or Veterinary Science, Livestock husbandry, extension methods, and written technical communication.

Desirable: Experience in staff management and estimate preparation, ability to liaise with graziers, report on rangeland and livestock management.

DUTIES: Responsible for development of livestock and rangeland programmes and contributing to development of research projects, liaise with other organisations involved in arid management and research.

INQUIRIES: Mr B. Mullins (02) 217-5236
Mr R. Southwood (068) 811-285

GENERAL: In the event of an overseas applicant being successful in applying for this position, consideration will be given to payment of removal expenses, fares, etc., subject to the applicant entering into a bond to remain in the service for a period of three years.

Applications are to be submitted to the Personnel Officer, Department of Agriculture, Level 10, PO Box K220, McKell Building, Rawson Place, Haymarket, 2000, N.S.W., Australia. Applications close on Friday 16 March, 1984.

HUMBERSIDE COLLEGE OF HIGHER EDUCATION

Science Technicians

£5640 - £6135

Applications are invited for three posts which provide technical support to teaching, research and consultancy activities in the School of Science, Cottingham Road Site, Hull. The successful candidates will be responsible for laboratories in the following fields:

BIOLOGY – Experience in Microscopy an advantage

CHEMISTRY – Experience in modern instrumental techniques an advantage

PHYSICS – Experience in Electronics, Microprocessors or Computing an advantage

Applicants for these Scale 3 posts should possess a relevant degree, Higher Diploma or Higher Certificate.

Further details and application forms from:

The Personnel Office, Humberside College of Higher Education, Inglemire Avenue, Hull HU6 7LU. Tel: (0482) 446506.

Closing date: 3 March, 1984.

Scientists

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If you want a career with a future, where you are rewarded according to your effort then consider selling. We have vacancies with major companies in medical/scientific equipment, pharmaceuticals and diagnostic reagents, throughout the U.K.

For a local interview to discuss an exciting future ring Sutcliffe Selection 0256 55955, (24 hours) 46/48 Essex Road, Basingstoke, RG21 1TB.

Sutcliffe Selection

MID STAFFORDSHIRE HEALTH AUTHORITY
St George's Hospital
Department of Microbiology
MEDICAL LABORATORY SCIENTIFIC OFFICER

Applications are invited from suitably qualified state registered MLSO's for the above post. Applicants must hold an HNC/HND in Medical Laboratory Science (Microbiology) or appropriate science degree and hold registration of the Council for Professions Supplementary to Medicine. Application forms and further information may be obtained from Mr I. L. McCartney, Senior Chief MLSO, Microbiology, St George's Hospital, Corporation Street, Stafford. Tel 45425. Closing date 2 March, 1984.

Please quote reference NS7 in all correspondence.

West Midlands County Council

CONSUMER SERVICES DEPARTMENT

CHIEF ANALYST

To £16,806 – Post Ref. TS 38

The successful applicant will be responsible for the economic and effective operation of the County's Analytical Laboratory which comprises a new, purpose built complex manned by 26 staff. The wide range of analytical functions includes those under the Food and Drugs, Agriculture, Consumer Protection, Health and Safety at Work and Control of Pollution Acts.

The postholder also acts as consultant to Departments of the Council and is a member of the Consumer Services Departmental Management Team.

Applicants must be Chartered Chemists and hold a qualification of M.Chem.A. Wide experience in the analytical field, as a senior manager and in the provision of revenue earning services is essential.

RELOCATION EXPENSES AVAILABLE.

ESSENTIAL CAR USER ALLOWANCE PAYABLE.

For an application form and further details, write or telephone, quoting post reference number, to:

County Personnel Officer, West Midlands County Council, County Hall, 1 Lancaster Circus, Queensway, Birmingham B4 7DJ. Telephone No. 021-300 7825.

A 24-hour telephone answering service is in operation.

Closing date for receipt of applications: 1st March, 1984.

The County Council is an Equal Opportunities Employer.

Brighton Health Authority

ROYAL SUSSEX COUNTY HOSPITAL

MEDICAL PHYSICS TECHNICIAN (2)

(Nuclear Medicine)

Applications are invited for the above post in the Medical Physics Department.

The successful candidates will be concerned with the provision of the Nuclear Medicine Service to the Brighton Health Authority.

Previous experience in radio-isotope organ imaging and radioisotope procedures is essential. A knowledge of data processing and computer techniques would be an advantage.

Salary £7386 pa rising by 8 annual increments to £9212 pa.

Informal visits welcome.

Application forms obtainable from the Unit Personnel Officer, Royal Sussex County Hospital, Eastern Road, Brighton BN2 5BE. Tel. Brighton 606611 Ext. 106.

Lothian Regional Council

NAPIER COLLEGE OF COMMERCE AND TECHNOLOGY

LECTURER A in POLYMER SCIENCE AND PHYSICAL CHEMISTRY

Salary on Scale £8313 - £12 228 (bar) - £13 125

A Chemist or Polymer Scientist is required to lecture in Polymer Science and Physical Chemistry on a range of courses, including the CNAA BSc course in Applied Chemistry which the Department of Applied Chemical Sciences runs in association with the Scottish College of Textiles, Galashiels.

Candidates should have a proven record of research and would be expected to show the ability and motivation to develop this in line with the needs of the Department and College, and in particular to support research in an area which relates to an Honours extension of the degree course which is expected to commence in September, 1984.

A good Honours degree, or equivalent qualification, in Chemistry or Polymer Science is essential. A higher degree, and industrial experience, would be desirable.

Application forms and further particulars from:

The Administrative Officer (Personnel)
Napier College of Commerce and Technology
Colinton Road
Edinburgh EH10 5DT

To whom they should be returned by: 9 March, 1984.

Chemical Engineers, Chemists & Health Physicists

Challenging Opportunities

The Atomic Weapons Research Establishment at Aldermaston, Berkshire, is engaged in a challenging and significant weapon development programme as well as considerable enhancement of its capital facilities.

Chemical Engineering and Chemical Plant Operations

Chemists and Chemical Engineers are responsible for a wide range of work associated with the design, procurement, commissioning and operation of full scale plant. Other work involves the fabrication and processing of particular composite materials for use in weapon technology and the operation of gas purification plants for the processing of radioactive, toxic, pyrophoric and chemically reactive materials.

Operational Health Physicists

Posts concerned with all aspects of radiation protection, handling of radio nuclides, review of personal dosimetry and bio-assays. Duties also include the occupational hygiene and safety aspects of a major industrial site.

Candidates must have a degree or equivalent in a relevant subject or corporate membership of an appropriate professional institution. They should also have at least 2 years relevant professional experience.

Salaries range from £7175-£9680 according to qualifications and experience with the prospects of advancement to senior management posts. Some posts attract additional allowances.

Relocation assistance may be available.

Rented housing may be available for married recruits living beyond normal daily travelling distance. Boundary Hall Hostel is available for those requiring single status accommodation. The AWRE Recreational Society offers facilities for most recreational activities.

For further details and an application form (to be returned as soon as possible) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Please quote ref: T(4)85.

AWRE Aldermaston AWRE

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Our clients are engaged in advanced Defence and Aerospace Projects and require **Systems Engineers** with experience in MODELLING, SIMULATION, FEASIBILITY STUDIES, TRIALS ANALYSIS, SIGNAL PROCESSING, OR, HARDWARE/SOFTWARE DESIGN.

A number of requirements exist at project management level and with opportunities throughout the UK we can quickly advise you on positions which suit your requirements.

For a Free Information Pack and an application form contact John Spencer at the address below or send a detailed CV. Full confidentiality assured.

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-Consumer Products

A New Career Path

As a result of increasing demand for new products to meet Company growth targets, opportunities have arisen within our Consumer Products Development Department for graduate level scientists and technologists who are seeking a new career path and wish to train as packaging technologists.

The work involves the development of packaging components and complete packaging systems for a wide variety of consumer products including cosmetics, toiletries, foodstuffs and pharmaceuticals. The department is accommodated in recently opened, purpose-built laboratories in Nottingham.

Industrial experience is essential. Involvement in materials technology in a creative environment would be ideal. You will need to demonstrate the ability and willingness to take up this new challenge and be self-motivated. Career advancement for the successful candidates is a strong possibility.

Salaries will reflect any relevant experience. Other benefits include profit sharing, staff discounts and group medical schemes. Relocation to the area is available, if applicable.

Write or telephone for an application form to: Mr T W Flower, Employment Manager (Technical), The Boots Company PLC, Station Street, Nottingham NG2 3AA. Tel: Nottingham (0602) 506255, Ext 243.

Boots The Boots Company PLC

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
MRC/University Circulation Research Unit
ASSISTANT RESEARCH OFFICER

Applications are invited from suitably qualified persons, regardless of sex, race, colour or national origin for appointment to the post of Assistant Research Officer in the University Circulation Research Unit.

The Assistant Research Officer will be expected to participate in an ongoing programme on the control of coronary blood flow in health and disease, as well as the biochemistry of autonomic receptors in the cardiovascular system. Applicants should have at least a BSc Honours degree with a background in physiology, biology, zoology, biochemistry or veterinary science.

The salary attached to this post will be within the range R9075-R14 217 pa. A pensionable allowance of 12% is also payable. The initial notch will be determined by the qualifications and experience of the successful applicant.

Intending applicants should obtain the information sheet relating to these posts from the Secretary, South African Universities Office, Chichester House, 278 High Holborn, London WC1V 7HE, England or from the Assistant Registrar (Academic Staffing) University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg 2001 South Africa with whom applicants should be lodged not later than 31 March, 1984.

GRADUATE ENGINEER

£9,400-£11,400

Our successful Design Advisory Service, which offers manufacturing companies help in the solution of wide-ranging design problems, is now operating a Funded Consultancy Scheme under which more then one thousand companies are currently being given financial help to use design consultants.

A graduate engineer (male or female) is needed to deal with applications under the Scheme, to participate in the selection of consultants for specific projects and to ensure that projects are carried out in accordance with agreed procedures.

Applicants should have a broad knowledge of engineering design in manufacturing industries, with an understanding of design problems outside their own specialist field. Experience in product design is desirable.

Benefits include a non-contributory pension scheme and flexible working hours.

For further details and an application form please contact:
Mrs Carol Taylor
Personnel Officer
The Design Council
28 Haymarket
London SW1Y 4SU
Telephone 01-839 8000 ext 35

THE DESIGN COUNCIL

UNIVERSITY OF WARWICK

Applications are invited for the following research posts in the Department of Chemistry and Molecular Sciences.

(a) POSTDOCTORAL RESEARCH FELLOWSHIP
(Physical Chemistry/Physics)

To investigate the potential of Langmuir-Blodgett films, coated on electronic devices, as sensors for chemicals. Applicants should have a background in either physical chemistry or physics and should have an interest in both Langmuir-Blodgett films and in solid-state devices. The post is for two years. Initial salary up to £8530 pa on the Research Range IA scale £7190-£11 615 pa

(b) POSTDOCTORAL FELLOWSHIP
(Membrane Biochemistry)

To study the structure and properties of olfactory sensory membranes. Applicants should have a strong background in membrane biochemistry or enzymes and an interest in receptor proteins. The post is for two years. Initial salary up to £8080 pa on the Research Range IA scale £7190-£11,615 pa

(c) RESEARCH ASSISTANT
(Biochemistry)

Graduate research associate to study the biochemical aspects of flavour perception. The work will involve both binding studies and chemical modification methods. Applicants should have a good honours degree in biochemistry or biological chemistry. Initial salary up to £7190 pa on the Research Range IB scale £6310-£8530 pa

Applicants should state for which post they wish to be considered. Applications (no forms) should include a full curriculum vitae and the names of two referees to Dr G H Dodd, Department of Chemistry and Molecular Sciences, University of Warwick, Coventry CV4 7AL, to whom informal enquiries may be made (Tel 0203-24011, Ext 2234)

UNIVERSITY OF ABERDEEN
Department of Bio-Medical Physics and Bio-Engineering
ELECTRONIC ENGINEER OR PHYSICIST

of practical bent required in department of international reputation, to maintain electronic imaging equipment containing computers, particularly two X-ray CT Scanners in modern teaching hospital. Training will be provided. Salary within Grade IA Scale for Other Related Staff, £7190-£11 615 pa, depending on qualifications and experience.

Further particulars and application forms from The Secretary, The University, Aberdeen with whom applications (two copies) should be lodged by 15 March, 1984.

RESEARCH OFFICER

ENGINEERING DEPARTMENT

A Research Officer is required to assist with work on projects concerned with control and instrumentation in relation to food processing. The work will include the use of conventional and computer based equipment both at the Research Station and in commercial processing plants.

Applicants should have had formal training in Chemical, Mechanical, Process or Control Engineering and have a specialised knowledge of instrumentation and control theories and concepts. Practical experience on the selection, calibration and installation of control systems will be an advantage.

Salary will be dependent on age, qualifications and previous experience.

Applications should be made to the Secretary-General, Campden Food Preservation Research Association, Chipping Campden, Glos GL55 6LD.

UNIVERSITY OF MANCHESTER
RESEARCH TECHNICIAN

Required for a three year research project on auto-antibodies to collagen and cartilage in the chronic inflammatory arthritides. The work will involve immunoassays and immunoflourescence and previous experience with immunological techniques would be beneficial. Candidates must have at least ONC and 3 years relevant experience. Salary scale £5151 to £6035 pa.

Applications with details of age, experience, qualifications and two referees to: Dr R. B. Clague, Room 2:530, Department of Rheumatology, Stopford Building, University of Manchester, Oxford Road, Manchester M13 9PT.

CANCER RESEARCH CAMPAIGN

Normal Tissue Radiobiological Research Group
Churchill Hospital
Oxford

Vacancies exist for an

ELECTRONICS TECHNICIAN
and a
RESEARCH TECHNICIAN

to work in an expanding cancer research group. The technicians appointed will be required to assist in a wide range of interesting research projects.

The electronics technician would be encouraged to design, construct and maintain various items of specialised equipment. The appointment would be on scale III or IV for Medical Physics Technicians, salary in the range of £5552-£6588 pa depending on qualifications and experience.

The research technician should have an interest in biological sciences and experience in histology and/or cell culture techniques would be and advantage but not essential. This appointment would be on the scale for Medical Laboratory Scientific Officers (salary range £5491-£6436 pa).

Qualifications for both posts, ONC, HNC or equivalent. The successful candidates would be expected to show a degree of self-motivation although guidance and training with specific techniques would be given.

Further information from Mrs B Whitehouse, Oxford 64841 extension 548 or Mr D Wellington extension 837. Applications to the Director of Radiobiological Research, Research Institute, Churchill Hospital, Oxford, with the names of two referees, by 29 February 1984.

UNIVERSITY COLLEGE LONDON

Department of Electronic and Electrical Engineering

TWO RESEARCH ASSISTANT POSTS IN MICROWAVES AND RADAR SYSTEMS

The Department is engaged in a number of sponsored research projects on microwave systems and advanced radar involving wideband microwave receivers, direction finding and radar techniques. There are two current vacancies for work in this area and, ideally, candidates should have some relevant background in these subjects, but applications will also be considered from recently qualified graduates in electronic engineering or physics. In suitable cases it may also be possible to read for a higher degree.

Salary in range £8376-£10 161 pa inc London Allowance.

Please reply, with relevant background details, to Professor D. E. N. Davies, Department of Electronic & Electrical Engineering, University College London, Torrington Place, London WC1E 7JE.

Southampton
THE
UNIVERSITY

DEPARTMENT OF OCEANOGRAPHY

RESEARCH ASSISTANT— Physical Oceanography/ Remote Sensing

A good honours graduate in physical science is required very soon to fill a post in connection with a MoD research contract using satellite data to study the dynamics of the N Atlantic Ocean. Salary range 1B (from £6310-£8530). Enrolment for a research degree encouraged.

Applications with full CV and names of two referees to Dr I. S. Robinson, Department of Oceanography, University of Southampton SO9 5NH, UK from whom further information is available.

ENGINEERS—Mechanical, Electrical, Electronic seeking a position of any level anywhere please submit your curriculum vitae and we will seek out opportunities. No charge to you. WSA (Engineers), 2 Greens End, London SE18 6HX (Agency).

Research Assistant
Clinical Pharmacology

G. D. Searle is an international pharmaceutical company with its UK headquarters at High Wycombe. We are currently looking for a Research Assistant to work in the Clinical Pharmacology Unit, designing and performing research projects on healthy volunteers.

There will be a particular emphasis on cardiovascular monitoring, and other areas of interest include gastro-intestinal and diuretic research.

The work is varied and interesting, and candidates must be able to work under pressure from time to time. A flexible approach to hours worked is essential.

It is anticipated that candidates will have a degree in science with a major in either physiology, or pharmacology, or possibly pharmacy. Previous experience in the pharmaceutical industry is not essential, although it would be an advantage.

Searle offers excellent salaries and conditions of service, including 23 days holiday, contributory pension fund, health insurance scheme, subsidised cafeteria, recreation club and pleasant offices in an attractive location.

Please apply to Miss D. Wardman, Assistant Personnel Officer, Searle Research & Development, Lane End Road, High Wycombe, Bucks (Tel: High Wycombe 21124, Ext 3254). Please quote reference B90/RA.

SEARLE

UNIVERSITY OF OXFORD

NUFFIELD DEPARTMENT OF ANAESTHETICS
John Radcliffe Hospital
Oxford

Statistics and Computing Assistant

Applications are invited from graduates in mathematics, statistics or computing for the above post in an integrated University/Hospital department. Duties are to collaborate with scientific and medical staff in the application of computation and statistics to problems arising from clinical and research work. Candidates expecting to graduate in 1984 can apply. The Department has extensive computing facilities including a range of microcomputers and access to the University main-frames.
Salary Scale: £6277 to £8439 pa (1st or 2nd Class Hons Degree) *or* £5681 to £8439 (other science degree) according to age and experience.
Application forms and further particulars from: Dr C. Hahn, Nuffield Department of Anaesthetics, University of Oxford, Radcliffe Infirmary, Oxford OX2 6HE. Tel Oxford (0865) 727342 (direct line).

FIELD STUDIES COUNCIL

Drapers' Field Centre, Betws-y-Coed, N. Wales

Three posts for students or graduates seeking temporary work and keen to help in a new-style catering operation. Time off to participate in the scientific and teaching work of the Centre. Would suit graduate in environmental subject interested in a career in this field.

UNIVERSITY OF STRATHCLYDE

Department of Bioscience and Biotechnology

(Applied Microbiology Division)

Postdoctoral Research Fellow

Applications are invited for a Postdoctoral Research Fellowship (tenable for three years) to work with Dr D. R. Berry and Dr J. Johnson on the genetic manipulation of yeast strains. Candidates should have experience of nucleic acid biochemistry or molecular biology.

Salary on Range 1A (£7190-£11 615 pa) on the national salary scale for Research Staff. USS benefit.

Applications (two copies) with curriculum vitae and the names and addresses of three referees (quote ref: R5/84) should be sent to Dr R. S. Henderson, Department of Bioscience and Biotechnology, University of Strathclyde, 204 George Street, Glasgow G1 1XW by 23 March, 1984.

MICROBIOLOGIST

required for busy Consultants Laboratory to assist with a wide range of Microbiological analyses and investigations. The post will provide an opportunity for a recent graduate in an appropriate subject to gain experience in a variety of areas. Salary according to qualifications etc. Please apply in writing with a full curriculum vitae to Lyne, Martin & Radford, The Public Analyst's Laboratory, 220 Elgar Road, Reading RG2 0DG.

UNIVERSITY COLLEGE CARDIFF
Department of Biochemistry

GRADUATE RESEARCH ASSISTANT

Applications are invited for this post within the Cadmium Group to work with Drs J. Kay and A. Cryer to develop immunoassay procedures for the quantitation of metallothionein in Human Tissues and Fluids. The project (in collaboration with Professor J. S. Garvey, Syracuse University, USA) will involve such techniques as affinity chromatography, production of polyclonal antisera and monoclonal antibodies and radioimmunoassays.

The appointment, financed by the Health and Safety Executive will be for one year with a starting salary of £6310. Duties to commence as soon as possible.

Applications (two copies) including names and addresses of two referees should be sent to the Vice-Principal (Administration) and Registrar, University College, PO Box 78, Cardiff CF1 1XL.

Closing date 8 March, 1984. Ref 2749

UNIVERSITY OF BIRMINGHAM

Department of Engineering Production

RESEARCH OFFICER

Applications are invited for the above post to work on a multi-racial anthropometric survey of hands and arms. The work is funded by the Health and Safety Executive. Candidates should preferably have a qualification in Ergonomics and experience of anthropometric surveys, on line computing and statistics.

Post tenable for up to one year from 1 March, 1984 or as soon as possible thereafter.

Salary on the Research Associate 1B scale £6310-£8530 plus superannuation.

For further particulars phone 021-472-1301 Ext 2559 quoting reference P2.

No formal application form. Three copies of application, including full curriculum vitae and naming three referees to Assistant Registrar (Science and Engineering), PO Box 363, Birmingham B15 2TT, by 2 March, 1984.

MRC
CLINICAL RESEARCH CENTRE
(NORTHWICK PARK HOSPITAL)
WATFORD ROAD, HARROW,
MIDDLESEX HA1 3UJ

TECHNICIAN

A vacancy exists in the Division of Immunochemical Genetics for a Technician with a Degree, HNC or equivalent qualification in chemistry or biochemistry.

The work of the division is concerned with the molecular basis and genetic regulation of carbohydrate antigens as exemplified by certain blood group antigens. The successful applicant will be required to isolate oligosaccharides from natural sources and to undertake chemical syntheses of disaccharides and nucleotide sugars by established procedures. Previous experience in carbohydrate chemistry would be an advantage.

Salary will be on the scale £6087-£8343 (inclusive of London weighting) depending on age and experience. Application forms and further details may be obtained by applying in writing to Miss J. Cottam, Personnel Section, quoting Ref 134/2/3649. Closing date for applications, 9 March, 1984.

YOUNG GRADUATE SOFTWARE ENGINEERS

AVIONICS PROJECTS

Rural Location to £11 000 pa.

This is a superb opportunity for young, enthusiastic engineers with Real-Time software experience to join a highly successful British Company currently developing an exciting range of high technology products.

Ideally, you will have experience of CORAL, PASCAL, INTEL 8086 ASSEMBLER gained in an avionics or other Real-Time environment; but any Real-Time microprocessor experience, especially utilising PDP11's would be useful. Successful applicants will form an in-company "software house" assuring variety of projects and first-class training.

The salaries are excellent and the attractive benefits include full relocation, subsidied restaurant and pension scheme including free life assurance. Five weeks holiday, optional over-time and flexible working hours complete the package.

With the rural location, a choice of village or town properties at sensible prices is available and, for "outdoor" types, a wide variety of water and field sports are at hand.

To further your career and enhance your lifestyle, telephone **Beverley Leonard on Bristol (0272) 277195,** or send a full curriculum vitae to:

3 Marsh Street
Bristol BS1 1RT

The Recruitment Partnership

ROTHAMSTED EXPERIMENTAL STATION
HARPENDEN, HERTS AL5 2JQ

A graduate qualified LIBRARIAN is required to fill the post of Deputy Librarian.

The successful applicant will be responsible for the reference desk and all READER SERVICES including circulation control, online provision of information, inter library lending and user education. Applicants should be able to work on their own initiative and assess priorities

The post requires an outgoing person with the ability to liaise and communicate at all levels.

Qualifications: Degree in a relevant scientific discipline with Diploma in Information Science or Associateship of the Library Association. Experience of online information retrieval and staff supervision preferably in an academic, scientific or technical library.

Appointment in the grade of Assistant Librarian (£5876–£8078). Non-contributory superannuation.

Apply in writing to the Secretary giving the names and addresses of two referees and quoting Ref: 540 by 9 March, 1984. Further details on request

CENTRAL BIRMINGHAM HEALTH AUTHORITY

Birmingham Maternity Hospital

BASIC GRADE CYTOGENETICIST

Applications are invited for a Basic Grade Cytogeneticist. The Cytogenetics Laboratory is situated in the Infant Development Unit at the above Hospital. This Laboratory provides a comprehensive service for the Birmingham area and a large part of the West Midlands Region. Applicants should hold a 1st or 2nd Class Science Honours Degree. The salary is £6277-£7953 pa.

Arrangements to visit the Laboratory may be made with Mrs S. Bowser-Riley, Principal Cytogeneticist.

For an application form and job description, please telephone the Personnel Department on 021 472 1377 Ext 118.

Closing date: Thursday, 1 March, 1984.

ELECTRON MICROSCOPY TECHNICIAN

The Electron Microscopy Unit of the University of New Brunswick is seeking an experienced electron microscopy technician to assist with the preparation of biological specimens, and the operation of a scanning electron microscope. Duties will also include darkroom operations and some transmission electron microscopy.

The EM Unit is a multi-disciplinary, regional facility, equipped with a scanning electron microscope, energy dispensive x-ray analyser, two transmission electron microscopes, preparation equipment for biological and materials specimens, and two darkrooms.

Candidates should have a university degree, or equivalent, in the biological sciences, plus experience in the electron microscopy of biological specimens.

The appointment will initially be for 1½ years, with salary based on qualifications and experience.

Applications, including resume and names of three referees, should be sent to:

Personnel Services
University of New Brunswick
P.O. Box 4400
Fredericton, New Brunswick
E3B 5A3

For more information on the position, contact:

Gerry Bance
E. M. Unit
University of New Brunswick
Bag Service 45111
Fredericton, New Brunswick
E3B 6E1

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian Citizens and permanent residents.

UNIVERSITY OF NEW BRUNSWICK

PROTEIN BIOCHEMIST

A senior biochemist is required to join a team working on scrapie and the related unconventional slow infections of the CNS. The appointee will be expected to develop and lead an innovative research programme to characteries (a) the infecious unit of scrapie (b) a gene product controlling the disease (C) cerebral amyloid and (d) scrapie-associated fibrils.

Applicants should have a good honours degree in chemistry or biochemistry and a PhD or the equivalent. A considerable proven research record in protein biochemistry is essential, preferably with experience in the analysis of hydrophobic proteins. The appointment will be as Principal Scientific Officer with salary in the range £11 343 – £14 931.

Applications giving full curriculum vitae and names of two referees to The Secretary, AFRC MRC Neuropathogenesis Unit, West Mains Rd., Edinburgh EH9 3JF.

CITY OF LONDON POLYTECHNIC

ANIMAL/
LABORATORY TECHNICIAN
£7000 to £7900

Applications are invited for appointment to a post of Technician in our Psychology Department based in Old Castle Street, London E1 close to Aldgate and Aldgate (East) stations.

Apart from specific responsibility in connection with the animals, the successful candidate will spend a significant proportion of time on general departmental technician duties.

Formal qualifications at ONC level or higher are required. At least five years relevant experience including work with animals, preferably rodents, is necessary. Experience of basic electronics and some computer familiarity would be an advantage.

Good conditions of service are similar to those of Local Government. Salary scale: £7046 to £7922.

For further details and an application form please write on a postcard, to the Staff Records Officer, City of London Polytechnic, 117 Houndsditch, London EC3A 7BU quoting reference 84/10.

QUEEN MARY COLLEGE

University of London

LECTURESHIP IN APPLIED MATHEMATICS

Applications are invited for this LECTURESHIP available from 1 October, 1984. Preference will be given to candidates whose research interests are in classical general relativity and/or theoretical astronomy. The successful applicant will be expected to teach mathematics both to specialist students and to other students in the Faculties of Science, Engineering and Social Studies.

Salary on scale £7190-£14 125 pa. plus £1186 London Allowance.

Application forms and further details obtainable from The College Secretary, Queen Mary College, Mile End Road, LONDON, E1 4NS, to be returned by 12 March.

THE UNIVERSITY OF SHEFFIELD

WEST RIDING CHAIR OF MICROBIOLOGY

Applications are invited for the above Chair, which fell vacant on the appointment of Professor J. R. Quayle, FRS to the Vice-Chancellorship of the University of Bath. The Chair will be tenable from 1 October, 1984.

Salary in the range for professional appointments (average £20 300: minimum £17 275). Particulars from the Registrar and Secretary (Staffing), The University, Sheffield S10 2TN to whom applications (one copy), quoting the names of three referees, should be sent by 5 March, 1984. Quote ref: R32/H.

THE MIDDLESEX HOSPITAL MEDICAL SCHOOL

Department of Medicine

TECHNICIAN (MLSO)

To assist with a project requiring assesment of the pituitary-adrenal axis. The work will include measurement of drugs and hormones by using radioimmunoassay, high pressure liquid and gas chromatography.

Salary is in the range £6480-£7140 (including London Allowance) and is for one year.

Applications with details of two referees to Dr J. W. Honour, Cobbold Laboratories, The Middlesex Hospital Medical School, Mortimer Street, London W1N 8AA. Closing date is 8 March

THE UNIVERSITY OF SHEFFIELD

Department of Microbiology

GENE EXPRESSION AND MANIPULATION

Applications are invited for a **Postdoctoral Research Assistant** financed by the SERC for work on the expression and *in vitro* mutagenesis of the genes encoding the respiratory succinate dehydrogenase of *E. coli*. Tenable from 1 May, 1984 or later, for 17 months. Initial salary £7190-£8975 a year, Range 1A. Experience in molecular genetics or protein biochemistry desirable, but not essential. Further information, by letter or telephone (0742-78555 Ext 4406) from Professor J. R. Guest, Department of Microbiology, the University, Sheffield S10 2TN, to whom applications, including *curriculum vitae* and the names of two referees, should be sent by 5 March, 1984.

Quote ref. R36/H.

UNIVERSITY OF BRADFORD

School of Polymer Science

POSTDOCTORAL RESEARCH ASSISTANT

in Reinforced Reaction Injection Moulding (RRIM). Applications are invited for the above SERC/PED funded post (which has considerable industrial support). The appointment, available for two years, will commence as soon as possible. The post is for work on the polymerisation chemistry of systems which might lend themselves to the reaction injection moulding process and will involve the use of RRIM equipment and the analysis of polymeric materials. Applicants should possess a PhD degree. Relevant research experience in the polymer field desirable. Salary in range £7090–£8530 pa.

Application forms and further particulars from the Personnel Secretary (Ref: PDRA/RRIM/NS), University of Bradford, West Yorkshire BD7 1 DP. Closing date asap.

THE UNIVERSITY OF MANCHESTER

RESEARCH ASSISTANT IN THE DEPARTMENT OF PHYSIOLOGY

Applications are invited for this Wellcome Trust funded post, tenable for a fixed period of eighteen months from 1 March, to work on the autoradiography of amino acid receptors in the brain. Candidates should have a first or upper second class Honours degree in an appropriate biological subject. Initial salary: £6310 pa. Superannuation.

Applications, including a curriculum vitae and the names of two referees, should be sent to Dr P. Slater, Department of Physiology, The University, Manchester M13 9PT (061-273 8241, Ext 72).

CHARING CROSS & ST STEPHENS HOSPITALS, LONDON

Cytology Department

POST DOCTORAL RESEARCH ASSISTANT

Applications are invited for this position to conduct a broad based immunocytochemical study of various body tissue tumours. The applicant should have a higher degree and previous experience in immunochemistry and/or cytochemistry. The appointment is for two years with a salary range of £8239–£10 549, inclusive.

For further details contact the Unit Personnel Department, Brandenburgh House, 116 Fulham Palace Road, Hammersmith W6. Tel: 01-748 2040 ext 2992.

Closing date: 2 March, 1984.

FBC

FBC Limited is an international agrochemical company with a strong research base and certain industrial chemical interests. It has a leading position in the British market, affiliate companies in 14 other countries and an annual turnover of some £150 million.

Quality Assurance Officer

Nr. Saffron Walden, Essex

to monitor compliance with good laboratory practice (GLP) standards in our Toxicology, Metabolism and Residue Analysis Departments and related functions. The level of this appointment reflects the size and international importance of the toxicology and related functions in development of pesticides in a major agrochemicals concern.

Your responsibilities will include auditing studies, both in-house and at contract laboratories, monitoring departmental facilities and procedures and preparation and upkeep of associated GLP documentation.

You will have a degree in a scientific discipline, probably a biological subject, and at least 2·3 years experience of handling and reviewing scientific data, preferably in a toxicology laboratory. Familiarity with GLP regulations and the quality assurance function will be a distinct advantage. Your personal qualities will be most important in this position which demands an enquiring mind, attention to detail, sound reasoning and judgement, and the confidence and maturity to be able to deal tactfully and patiently with skilled scientific and management staff at all levels.

This appointment is open to both men and woman.

We offer a competitive salary supported by a substantial range of fringe benefits normally associated with a major international company, including relocation expenses, where appropriate.

Please write quoting reference No. CP973, giving full details of your career to date including current salary to Peter England, Personnel Officer, FBC Limited, Chesterford Park Research Station, Saffron Walden, Essex CB10 1XL.

British Calibration Service

Engineer or Scientist

Nationwide the British Calibration Service has 43 laboratories approved for work in the mechanical field and which carry out measurements of length, angle, form, force, impact and hardness as well as the calibration of universal force testing machines and concrete cube crushing machines.

This post at the National Physical Laboratory, Teddington, Middlesex, involves the assessment, approval and supervision of BCS laboratories in the field of mechanical metrology; organising and taking part in supervision visits to approved laboratories; paying promotional visits to prospective laboratories; advising on the BCS audit measurement scheme and acting as Secretary to the technical committee which advises BCS on mechanical metrology, and organising specialist working parties.

Candidates must be graduates in science or engineering **or** be Chartered Engineers **or** have an equivalent or higher acceptable qualification **or** have attained an equivalent standard of knowledge, training and experience **and** have at least 8 years post-graduate experience. They should also have a sound knowledge of and considerable experience in mechanical metrology, including metrology at the industrial level. A basic understanding of statistics as applied to metrology is essential. Some knowledge of optical metrology desirable.

Starting salary (including £500 Outer London weighting) in the range £13,710-£16,210 according to qualifications and experience. Promotion prospects.

RELOCATION ASSISTANCE MAY BE AVAILABLE.

For further details and an application form (to be returned by 9 March 1984) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote ref: T/6166.**

National Physical Laboratory

Cambridge Health Authority

Addenbrooke's Hospital
Hills Road, Cambridge

Technician in Clinical Neurophysiology

This is a clinical service department utilising a variety of electrophysiological and psychophysical methods to investigate central and peripheral nervous system function. EEG, ambulatory monitoring, Evoked Potentials and EMG techniques are used routinely in diagnostic testing, and there are on-going research projects. The successful applicant will be fully involved in all areas of work.

Applicants should ideally have OTEC/HTEC/ECNE or equivalent qualifications, and relevant experience. Appointment will be at the appropriate point on the Technician or Senior Technician scale (salary £4657-£7207).

Prospective applicants who wish to visit the Department or would like further information should contact Mrs J. Bradford, Chief Technician on 0223 245151 Ext 7136.

Application forms can be obtained from Personnel Department, Addenbrooke's Hospital, Hills Road, Cambridge CB2 2QQ. Closing date 2 March, 1984.

ASSISTANT SUPERVISOR

International publishers of scientific, technical and medical books wish to appoint an additional supervisor within a rapidly expanding copy preparation department.

Consideration will be given to candidates with previous experience of copy-editing and proofreading, as the work involves the supervision of freelance services.

Although a knowledge of chemistry, physics, mathematics or medicine would be an advantage, lack of qualification in these subjects would not disqualify the right person provided he/she could show evidence of similar responsibilities in a publishing office.

We offer non-contributory pension and medical schemes.

Applications in writing, stating age, experience, and present salary to Miss M. Redwood, Managing Editor,

John Wiley & Sons Limited
Baffins Lane, CHICHESTER, Sussex PO19

SOUTH EAST THAMES REGIONAL HEALTH AUTHORITY
in co-operation with the University of Surrey

The Authority offers a special training post as a BASIC GRADE PHYSICIST with the opportunity to study for an MSc in Medical Physics.

This post is available from October 1984 for a 2-year sandwich MSc course at the Universtiy. In the case of prospective graduates a good Honours degree in Physics (or its equivalent is essential).

During the parts of the course spent away from the University the student would work in a specified Hospital Physics Department within the Region. Salary would be at the appropriate point on the scale commencing at £6 277 pa and rising by one annual increment to £6 520 pa. A London Weighting Allowance is payable when applicable. Fees and expenses whilst attending University have to be met by the student. The Certificate of Proficiency will normally be issued on completion of the two year course.

Further details and application forms are available from the Academic Registrar, University of Surrey, Guildford, Surrey, GU2 5XH.

Closing date for receipt of applications: 30.3.84
Ref No: 412

STUDENTSHIPS

UNIVERSITY OF EDINBURGH
Department of Botany
in conjunction with
UNILEVER RESEARCH
Colworth Laboratory
Plant Biochemistry

A CASE studentship has been awarded for studies on the role of cytoplasmic calcium and membrane-bound protein kinase in controlling the division cycle of cultured plant cells and protoplasts.

Appointment is for three years with registration for MPhil/PhD degree. Undergraduates (or graduates) in Biochemistry/Plant Biochemistry or Biology/Botany with a strong physiological or biochemical bias may send applications (cv + two referees) to Dr A. Trawavas, Botany Department, University of Edinburgh, Edinburgh EH9 3JH or Dr W. Hughes, Unilever Research, Colworth House, Sharnbrook, Bedford

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DAVY FARADAY RESEARCH LABORATORY
The Royal Institution
RESEARCH STUDENTSHIPS IN CHEMISTRY

Applications for the above studentships (value £2995 pa plus fees) are invited from Honours students who expect to graduate in 1984. The successful applicants, while pursuing research in the Davy Faraday Laboratory may register as internal candidates for the PhD degree of London University. Research will be in the following areas of photochemistry and photophysics. Photosynthesis and picosecond laser techniques (Professor Sir George Porter). Supersonic jet spectroscopy, and applications of time-resolved fluorescence to biological systems (Professor David Phillips).

Applications and requests for further particulars to the Director, The Royal Institution, 21 Albemarle Street, London W1X 4BS.

THE OPEN UNIVERSITY

RESEARCH STUDENTSHIPS IN SCIENCE

The Faculty of Science at the Open University invites applications for full-time research studentships, Tenable from 1 October, 1984 at Milton Keynes and the Oxford Research Unit. A wide variety of research topics is available within the following Disciplines and research groups:

BIOLOGY including BRAIN RESEARCH GROUP

CHEMISTRY

EARTH SCIENCES including PETROGENESIS RESEARCH GROUP

PHYSICS including OXFORD RESEARCH UNIT

Successful applicants will be awarded either an Open University or Research Council research studentship. Applicants should normally have (or expect to gain in 1984) a good honours degree. For further particulars and application forms please send a POSTCARD to the **Higher Degrees Office S/2, The Open University, PO Box 49, Walton Hall, Milton Keynes, MK7 6AD or telephone Milton Keynes (0908) 653806.**

PLEASE SPECIFY THE AREA(S) IN WHICH YOU ARE INTERESTED AND QUOTE REFERENCE S/2.

Applications should be submitted as soon as possible.

THE UNIVERSITY OF LEEDS
DEPARTMENT OF PHYSICS

SCIENCE AND ENGINEERING RESEARCH COUNCIL STUDENTSHIPS

Applications are invited from persons holding, or expecting to obtain, a Class I or II (i) Honours degree in Physics, for studentships leading to the degree of PhD in the above Department.

A wide range of opportunities exist for research in the following areas:

ASTROPHYSICS
POLYMER PHYSICS
SOLID STATE PHYSICS
THEORETICAL PHYSICS

Applications giving the names and addresses of two referees, should be sent as soon as possible to Professor I. M. Ward, Department of Physics, University of Leeds, Leeds LS2 9JT, from whom further details are available.

LECTURES, MEETINGS AND COURSES

UNIVERSITY OF SURREY
Department of Physics

MSc COURSE IN RADIATION AND ENVIRONMENTAL PROTECTION

This full-time/part-time course provides a thorough grounding in the science of Radiation Protection and investigates its relationships to the broader field of Environmental Protection. The environmental consequences of large scale energy generation by both nuclear and non-nuclear power sources are studied. The course provides a bridge between the physical sciences and the life sciences and covers certain aspects of public health.

The course duration is a minimum of one year full-time, or two years part-time, on a day release basis, beginning each October.

This course is recognised by the Science and Engineering Research Council and a number of SERC Advanced Course Studentships are available, it has also been found suitable for support under the TOPS retraining scheme of the Manpower Services Commission.

For further details call:
Mrs Gwen Wallaca
Postgraduate Admissions Secretary
on Guildford (0483) 571281 Ext 576
or write Department of Physics,
University of Surrey,
Guildford, Surrey GU2 5XH
Telephone (0483) 571281 Ext 576

THE MIDDLESEX HOSPITAL MEDICAL SCHOOL AND ST BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE

(University of London)

MSc Course in Radiation Physics

(Full-time and Part-time)

Applications are invited for this course which is organised jointly by the above Schools of the University. The course extends over one year for full-time students, or two years for part-time students, and includes lectures and practical work on radiation and nuclear physics and their applications in radiotherapy, radiology, nuclear medicine and health physics. The normal entry requirement is a First or Second Class Honours Degree with Physics as a major component. The course is a suitable basis for a career in Medical Physics. Physicists working with radiations in medicine or industry can be accepted as part-time students. The Course is recognised by the Science and Engineering Research Council and Medical Research Council for the award of Advance Course Studentship.

Further information and forms of application can be obtained from the Secretary, Physics Department, at either of the above schools.

AVERY HILL COLLEGE

ENVIRONMENTAL STUDIES (CNAA)

Diploma of Higher Education
(leading to BSc Honours)

A two year full-time course for students concerned with environmental issues who want to achieve a broadly-based education in man's use of the natural environment

The first year concentrates on basic principles of the Life, Earth and Social Sciences, as well as providing a grounding in Quantitative Techniques. These principles are extended in the second year into Human Ecology, Energy Resources and Perspectives on Resource Development

There is a strong practical bias to the course and fieldwork and computer techniques are important elements.

By transferring directly into the Third Year at certain Polytechnics, students may gain BSc (Honours)

Mature prospective entrants without formal qualifications are invited to apply as well as students having normal college entrance requirements.

Details and application form from
Dr Euan McPhee, Programme Director, Dip HE Environmental Studies, Department N2, Avery Hill College, Bexley Road, London SE9 2PQ

ilea

CHELSEA COLLEGE
University of London

STUDY HISTORY AND PHILOSOPHY OF SCIENCE AT CHELSEA

One year MSc courses begin October, 1984. Facilities for MPhil and PhD by research. Applicants must posses a first degree in one of the natural sciences or mathematics. All courses approved for DES grant awards. Early application is advised since the closing date for applying for a DES award is 1 May.

Send details to Dr M. L. G. Redhead, Department of History and Philosophy of Science, Chelsea College, University of London, Manresa Road, London SW3 6LX. Tel 01-351 2488.

MS IN TECHNOLOGY AND SCIENCE POLICY, Georgia Institute of Technology. One year full time, two years part time. Alternative to the MBA or MPA for engineering and science graduates. Write Technology and Science Policy Program, School of Social Sciences, Georgia Tech, Atlanta, GA 30332.

EXPERT SYSTEMS EASTER SEMINAR

at the Polytechnic of North London, 24th & 25th April, 1984

This is a practical programme designed to give an intensive briefing on a new and dynamic software phenomenon.

The news about Expert Systems that appears in the press is necessarily distorted by over-simplification. Nevertheless Expert Systems have hit the headlines recently, because of their obvious commercial potential.

This course is intended to show how that potential can be exploited today, with today's software and hardware. All our speakers are actively involved in the field. They know how to put 'knowledge engineering' into practice, and can warn newcomers of potential pitfalls.

Why not take two days out over Easter to update your knowledge of knowledge-based systems? For full details write to

Werm Boot Limited (ES84)
23 Torrington Gardens
Bounds Green
London N11 2AB.

UMIST

MSc COURSE IN INTEGRATED CIRCUIT SYSTEM DESIGN

One year, full-time MSc Course in the Design and Fabrication of Microelectronic Components, Semi-Custom Devices and Systems. Student-designed circuits will be manufactured by local industry and using Departmental facilities.

Applications are invited from Honours Graduates in Electronic Engineering, Computer Science and Physics, or from holders of equivalent professional qualifications. Course recognised by SERC for Advanced Course Studentships, and by EITB for Industrial Sponsorship. Details and application forms from Postgraduate Admissions Tutor, Department of Electrical Engineering and Electronics, UMIST, PO Box 88, Manchester M60 1QD. Please quote reference EEE/C1/AJ.

TORIES AGAINST CRUISE & TRIDENT

TACT has two aims: to provide a focus for Conservatives who are opposed to the latest escalation in the arms race (Cruise and Trident), and to help rectify the imbalance in the political image of the disarmament movement.

For further information send
SAE to TACT
Sue Cosslette, 5 Waverley Place,
Finsbury Park, London N4 2BU

Royal Postgraduate Medical School

(University of London)

MSc Degree Course in Experimental Pathology (Toxicology)

Applications are invited for the above, one-year full-time course which is being offered from 1 October, 1984.

Applicants should possess a first degree in medicine, veterinary medicine or an appropriate science subject.

It is hoped that a number of Medical Research Council Studentships will be available.

Further details and application forms are available from:

School Office (MSc)
Royal Postgraduate Medical School
Hammersmith Hospital
Du Cane Road
London W12 0HS
Telephone: 01-743 2030 ext 351

Please note that the closing date for receipt of applications will be: 11 May, 1984.

THE BRITISH INDUSTRIAL BIOLOGICAL RESEARCH ASSOCIATON

IMMUNOTOXICOLOGY COURSE

A one-week residential workshop designed to provide a broad background knowledge to immunotoxicology and its significance in general toxicology will commence on 9th April. It will be orientated towards participants with little formal knowledge of the subject and places will be limited to allow personal tuition.

The course fee is £600 + VAT for tuition, hotel accommodation and all meals.

For details, please write to Dr K. R. Butterworth, BIBRA, Woodmensteme Road, Carshalton, Surrey SM5 4DS (01-643-4411|.

UNIVERSITY OF STIRLING

TECHNOLOGICAL ECONOMICS

One-year MSc course, including an industrial project, in **management science and business economics** for honours graduates, or equivalent, in science or engineering. Approved by the **SERC/SSRC Joint Committee** for award of Advance Course Studentships.

Sponsorship by industrial firms is welcomed.

Applications for the 1983/1984 programme are invited.

Details from:

M. S. Makower,
Department of Management Science,
The University of Stirling,
STIRLING FK9 4LA, UK

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

One-day Short Course

METHODS OF SURFACE ANALYSIS

Wednesday, 7 March, 1984

A number of techniques are available to measure the composition of the outermost surface layers of solid materials. This one-day course is aimed at introducing the non-specialist in industry to the analytical information available from Auger electron spectroscopy, ESCA, SIMS and Rutherford backscattering and the ways these techniques can be used to solve problems on surfaces, thin films and surface coatings. Further details from the surface analysis laboratory. Telephone (0509) 263171, Ext 5249

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FOOD TECHNOLOGY

Applications are invited for enrolment on this science based course for the food industry at ordinary and higher TEC Diploma level.

For further information, send SAE, quoting ref number A4 to R. W. James, Department of Food Technology, Birmingham College of Food, Summer Row, Birmingham.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

UNIVERSITY COLLEGE, CARDIFF
DEPARTMENT OF CHEMISTRY

POSTDOCTORAL FELLOWSHIP

Applications are invited for a Postdoctoral Fellowship for synthetic and biosynthetic studies related to haem and bile pigment metabolism. Experience in small scale preparative work and /or HPLC desirable. Excellent facilities are available including very high field NMR (360 MHZ) mass spectrometry and HPLC

The post is available from 1 March, 1984, salary range £7190-£8080 pa. Applications with curriculum vitae and names of two referees should be sent to Prof A. H. Jackson, Department of Chemistry, University College, PO Box 78, Cardiff CF1 1XL. (Preliminary enquiries may be made by telephone 0222-44211, Ext 2034.)

THE UNIVERSITY OF OXFORD

Graduate Awards at St Catherine's College

The College proposes to award five Graduate Scholarships of £200 per annum, tenable for two years in the first instance, for men or women commencing a research degree at Oxford in October 1984 in any subject. The awards are intended for those who have taken first degrees at universities within the UK and European Community (except Oxford).

The College also offers a Graduate Scholarship of £1500 per annum, for two years, and five Bursaries of £200 intended for graduates who are not citizens of a European Member State.

Further details may be obtained, before 30 April, 1984, from the Senior Tutor, St Catherine's College, Oxford OX1 3UJ.

UNIVERSITY OF GLASGOW
Department of Genetics
POSTDOCTORAL RESEARCH FELLOWSHIP

Applications are invited for a Postdoctoral Research Fellow to work with Dr G. Sutcliffe on a three year MRC-supported project that is aimed at the cloning and analysis of the gene for human placental alkaline phosphatase (PLAP). This is a tissue specific member of a presumptive multigene family of alkaline phosphatases, which exhibits a notable degree of polymorphism and is reactivated in certain tumours. In addition, our recent work suggests that PLAP exists in soluble and membrane-associated forms, which are structurally distant.

Prior experience in recombinant DNA methodology is essential.

The starting salary will be within Range 1A of the salary scale for Research and Analogous staff (£8530-£9425 plus superannuation), with an early starting date.

Applications (citing two referees) and enquiries should be sent to: Roger Sutcliffe, Department of Genetics, University of Glasgow, Glasgow G11 5JS (041-339 8855, Ext 7108). Please quote Ref. No. 5198N.

UNIVERSITY OF BIRMINGHAM
Department of Electronic and Electrical Engineering
POSTDOCTORAL RESEARCH FELLOWSHIP

Applications are invited for the above post which is funded by the MoD. The work is concerned with signal handling in high frequency receivers using digital techniques for filtering and demodulation. There are prospects for a wide range of work and also collaboration with other establishments. Both theoretical and practical skills are required and an abililty to direct and liaise with other staff will be important.

The post is tenable for up to one year from 1 April, 1984.

The salary is on the Research Fellow 1A scale £7190-£11 615 plus superannuation.

For further particulars phone 021-472 1301 Ext 2559, quoting reference S3.

No formal application form. Three copies of application, including full cv and naming three referees to Assistant Registrar, (Science and Engineering), PO Box 383, Birmingham B15 2TT by 2 March, 1984.

NEWNHAM COLLEGE CAMBRIDGE
VISITING RESEARCH FELLOWSHIP IN THE SCIENCES

Applications are invited from academically qualified women who wish to pursue research in Cambridge. The Fellowship, tenable at Newnham College, is for a period of at most 11 months (between 1 October and 31 August) and may be awarded either for 1984–85 or for 1985–86.

The purpose of the Fellowship is to enable visitors to the University, particularly those on sabbatical leave, to take part in the life of the College while undertaking their own work. No stipend is offered, but holders of the Fellowship are provided with a study in College and are entitled to meals without charge at the High Table. If required, further living accommodation may also be provided at a charge to be agreed with the College.

Further information may be obtained from the College Secretary, Newnham College CB3 9DF. The closing date for applications is 31 March, 1984.

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Inorganic Chemistry: *Professor B. G. Hyde, FAA, Professor A. M. Sargeson, FAA, FRS, Dr M. A. Bennett, FAA, Dr G. B. Robertson, Dr S. B. Wild*—Solid-state chemistry non-molecular crystal structures, electron microscopy/diffraction (Hyde). X-ray crystallography, neutron diffraction (Robertson). Synthesis, structure and mechanism of reactions of coordination complexes: reactions of coordinated ligands and their relation to biology and catalysis, reactive intermediates, quantitative conformational analysis, caged metal ions (Sargeson). Synthesis and catalytic properties of organotransition metal complexes (Bennett). Resolution of chiral tertiary arsines and phosphines using metal complexes, macrocycles, asymmetric synthesis (Wild).

Physical and Theoretical Chemistry: *Professor D. P. Craig, FAA, FRS, Dr J. Ferguson, Dr R. Bramley, Dr T. R. Welberry, Dr O. J. Evans*—Molecular and crystal theory (Craig). Spectroscopy and photochemistry (Ferguson). Optical and magnetic resonance studies of photophysical processes; magnetic resonance in zero field (Bramley). Optical analogue, X-ray diffraction and theoretical studies of disordered materials, particularly organic molecular crystals (Welberry). Liquid state chemical physics (Evans). Theoretical organic chemistry (Radom) is listed under Organic Chemistry.

The school is non-departmental and is well equipped to contemporary standards, especially in optical, NMR and EPR spectrosocopy, mass spectrometry, X-ray crystallography, electron miscrosocpy and liquid He cryogenics. A library and workshops are on the premises. The School is well supported by ancillary staff. In computing there is access to the School PDP 11/45 and the University Univac 1100/82 systems.

Applicants for scholarships should be of high scholastic calibre with capacity for research, and hold, or expect to hold, a good honours degree or equivalent from a recognised university.

Subject to satisfactory progress, a scholarship is tenable for the whole period of the course for the degree of Doctor of Philosophy, normally three years. In some instances, a scholar may be required to enrol initially in a course leading to the degree of Master of Science. Examination for both degrees is by submission and assessment of a thesis based upon research carried out during the course.

Basic Allowance $Aust. 6631 pa. tax free. (Approximate exchange rates at present are $Aust. 1.00=Stg 64p =$U.S. 90c). A scholar may apply for family allowances for his dependants. Return fares are mormaly paid, assistance with accommodation is given wherever possible.

For details and application forms write, stating field of research, to:
Professor L.N. Mander, Dean, Research School of Chemistry, The Australian National Universtiy,
G.P.O. Box 4, Canberra, A.C.T. 2601, AUSTRALIA.

Closing dates: 30 April 1984
31 October 1984
Applications may be made at any time

THE ROYAL SOCIETY

TRAVEL AND SUBSISTENCE GRANTS FROM THE PARLIAMENTARY GRANT-IN-AID

Notice is hereby given that the following closing dates will apply in respect of applications for travel and subsistence grants: 1 March, 1 June, 1 October and 1 December, 1984. Grants are awarded only in respect of short scientific visits overseas of up to 13 days (generally for Conference attendance), and applications should be submitted on forms to be obtained from the Executive Secretary, (Ref. BdeV), The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG, (01-839 5561, Ext 222). Grants are only available to scientists of at least PhD status who are ordinarily resident in the UK and are not in the employ of governmental or research council institutions.

For certain major conferences there may be special closing dates and those who may wish to apply should inquire as far in advance as possible, and in requesting forms should indicate the meeting they wish to attend.

Applications in respect of longer term visits overseas can be considered under other schemes administered by the Society, and those wishing to apply should inquire well in advance of travel indicating the approximate duration of the visit, and the country to be visited.

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Further details from:
Head of Science and Technology Department, Southall College of Technology, Beaconsfield Road, Southall, Middlesex UB1 2DP. Telephone 01- 574 3448, extension 253.

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ARIADNE

A NUMBER of my American friends have had great fun from time to time on encountering British plumbing. They have been astonished, for instance, to flush a lavatory in a hotel and find that, as far as they can hear, the water has gathered itself at the end of a mile-long pipe and then charged towards them with the noise of an express train. After it has hurtled, usually inefficiently, round the pan, and vanished, the system has recovered with groans, clanks and grumbles reminiscent of a knight in full armour adjusting his dress before leaving, and taking minutes to do it. I have usually countered this by quoting the American system of flushing from the mains as being liable to what water engineers term, with horror, back-siphonage, a phenomenon by which you may receive the contents of somebody else's lavatory pan through yours, an experience of little value, though educational.

So I was fascinated by the news of a new cistern valve made of plastic and with only two parts. It is, say the makers, DPM Design Consultants, fast-filling, quiet-acting and needs no maintenance. It is simply a floating plastic arm that rises as the water in the cistern does and eventually seals off a cunningly shaped hole where the water comes in. It is not, then, a ballcock, one of the most absurd devices ever thought of. Anyone who has tried to refloat a sunken ball valve will agree, as will anyone who has tried to adjust the flow of water into a cistern by the light of a torch. I suppose that ballcocks are still being installed, even in these days of foam plastics. A lump of that, unsinkable, will do the job, and it is a lot cheaper.

DPM seem to me to be potentially important benefactors of mankind, including, I must fearfully add, women, many of whom are forced to queue because cisterns do not fill quickly enough. □

YOU WOULD think that, to adapt a remark of Dr Johnson's, a man is seldom so innocently employed as when he is conserving nature. But the world is more complicated than that. So it is not more than a mild surprise to find that conservation is a danger to aircraft and their equipment.

A spokesman for Lucas Aerospace, commenting on collisions of jet aircraft with birds, said, "Nature conservation has resulted in bigger and healthier birds in larger numbers," in immaculate spokesman style.

A spokesbird said that it was a diabolical liberty and totally unacceptable to criticise their size and number. "We refuse to negotiate under duress," he added. "If they're against birds why do they name their aircraft after us, such as the Harrier?"

He refused to coment on reports that Lucas was firing dead birds at 500 m/h into windscreens while testing new materials. □

MUCH MORE agreeable than the usual dreary thoughts about this year is that 1984 is also the "Year of the water's edge" and so designated by the Council of Europe. That fact will hardly deter the Borough of Hounslow from approving the acquisition of the site of Duke's Hollow, on the north bank of the Thames at Barnes. A commercial firm wants a lease on it to develop a sports centre, a marina and a riverside bar. But vociferous opposition might have done the trick. (The borough's Environmental Planning Committee meeting about the question took place on 13 February.)

It's the first time I've produced negative lift
ME-PT 875

Duke's Hollow is a small area. It is though, the objectors say, one of the few natural bits of river bank left on the Thames, most of it being built up or embanked. The Chiswick Wildlife Group has made a survey of the life flourishing there and discovered, for example, that it harbours an extremely rare snail, the remarkably named two-lipped doorsnail, or *Laciniaria biplicata.* Rare to Britain, that is, for the snails are found in Belgium, Holland and Germany. But the site is more than a good place for two-lipped snails. It also has, among other wildlife, more than 52 kinds of birds and 52 species of beetle. Incidentally, the two-lipped snail is listed as "vulnerable", a term that means it is in danger of extinction in Britain.

The opposition to the leasing of the site makes a good case from its own particular interests which are, of course, not those that cut much ice with developers. I always think in more general terms. Why, for God's sake, can't we leave *something* alone? □

A RESIDENT of Rochdale tells me that the local council has had a lot of stickers printed. They read "nuclear free zone" and they are being plastered on the council's vehicles, rubbish bins and even lawn mowers.

With many others, I still have no idea what the nuclear free zone slogan is supposed to indicate or achieve. Perhaps a Rochdale councillor will tell me and I can pass the information on to people living in other areas of the country with the same proliferation of stickers and notices with the same device. □

THE WHEEL, says Daedalus, is a much overrated invention. Without a special track its jolting is intolerable. The key inventions were really the smooth rail, the levelled road, and the pneumatic tyre. One wheeled vehicle that needed no track was the ancient Greek chariot. Its wheels were so flexible that it could be galloped over quite rough country. So Daedalus is devising the ultimate Greek chariot-wheel—DREADCO's "Soggywheel" (Regd.). Instead of rigid spokes, it has extensible solenoid or hydraulic actuators.

As it rotates, a sensor in the hub monitors the level of the axle. Should a hole in the road threaten to lower the wheel, the sensor commands the relevant spoke to extend. This deforms the flexible rim of the Soggywheel, and the hole is accommodated. So the wheel provides absolutely perfect springing, and gives a dead-level ride on any track. It wastes little energy: on average the energy it delivers extending spokes into hollows is recovered when spokes are retracted from bumps.

Even better, the Soggywheel can propel itself. A kick from each spoke as it leaves the ground will drive the wheel forward: reversing and braking are also possible. This great gain in mechanical simplicity will easily outweigh the complexity of the sensing and command electronics. In fact, Daedalus has invented the ideal intermediate between the wheel and the leg, in which the same principles and trade-offs are taken to their ultimate extreme.

Soggywheels will revolutionise transport. With their reliability and utterly smooth ride, Soggywheeled vehicles will soon dominate the market. Road-maintenance will cease, and drivers will simply not notice as the motorways decay into crack-riddled, potholed irregularity. Railways, with their ballasted and sleepered expanses of track, will immediately become available as roads as well, giving rise to intriguing problems of precedence and signalling. Vast areas of the world, now accessible only on foot, will be opened up triumphantly by the universal Soggywheels. □

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DISCUSSIONS 1984

Dinosaurs—the masters of planet Earth

Dr Beverly Halstead

6.0 pm Sunday 11 March

FOR 140 million years the dinosaurs dominated life on Earth—they rank as the most successful vertebrates of all time.

Many popular films showing dinosaurs engaged in bloody battles are based on undisciplined imagination; however, it is possible to reconstruct the life of dinosaurs from scientific evidence—how they moved, how they fed, how they brought up their young, even their social organisation, all have been worked out from the clues they left behind. The manner of their disappearance remains a subject of heated controversy among many scientists.

Dr Beverley Halstead is reader in geology and zoology at the University of Reading and a research fellow at the Royal Dental Hospital, London. He has worked at the Natural History Museum in London, and at Oxford University. He was formerly professor of geology at Panjab University, Chandigarh, India. He has published many books, including *The Evolution of the Mammals.*

Dr Halstead is an expert on dinosaurs and says that the real excitement in his work is searching for fossils and "finding something that no other human being has ever seen before." His work has taken him to Central Poland, the USSR, China and many parts of Africa, including the Sahara Desert. On one Nigerian expedition, he and his party were arrested: they spent Christmas Day in detention and had only corned-beef sandwiches for their Xmas dinner!

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How we conquered the Universe and similar mistakes

Professor Jack Meadows

6.0 pm Sunday 18 March

WHAT happened in the history of science? You hear some colourful stories—for example, an apple falling on the head of Isaac Newton—but did it really happen? Anyway, who cares? Then again, scientists sometimes make mistakes. Is it best to hide these peccadillos beneath the carpet and forget about them?

Professor Meadows sets out to explore these sorts of questions, and hopes in so doing to show that tall stories and curious mistakes are an important part of science.

Professor Jack Meadows studied Russian at the University of Cambridge; physics and astronomy at the University of Oxford; and history and philosophy of science at the University of London. He has held university posts in the US, Scotland and England. He is currently head of the Departments of Astronomy and History of Science and of the Primary Communications Research Centre at the University of Leicester. He has written various books on astronomy, history of science and communications, and an excessive number of papers on these and other topics.

How life evolved with some help from Gaia

Professor James Lovelock

6.0 pm Sunday 25 March

COMPARED with our planetary neighbours, Mars and Venus, the Earth is a strange and beautiful anomaly. How did it come to be so different?

We are usually taught that we are very fortunate to have evolved on a planet that was by chance just right for life, or, for those rare times and places when it was not, life has been able to adapt. Professor Lovelock presents a radical alternative; that the Earth is a pleasant and fit place for life because life has made and kept it so. This alternative view is the Gaia hypothesis, so named after the Greek goddess of the Earth.

To illustrate this notion, Professor Lovelock traces the development of the planet and the evolution of life from its origins until today. What are the arguments for and against Gaia? How is pollution damaging the environment of a living Earth? What insight does the Gaia hypothesis offer that might help us to solve the contemporary problems of the environment? Can it tell us how to live with, as well as on, the Earth?

Professor James Lovelock graduated in chemistry at the University of Manchester, and subsequently gained degrees in medicine and biophysics at the University of London. For 20 years, he worked with the Medical Research Council at the National Institute for Medical Research, and at the Common Cold Research Unit. He has worked in the medical schools at Harvard and Yale Universities, and at Baylor University College, in Houston, Texas, where he was a professor of chemistry. Since 1964 he has conducted independent research and has been a visiting professor, at Houston and Reading Universities.

Professor Lovelock is the author of various books, including *Gaia and the Great Extinction,* and many research papers. He has also patented about 30 inventions, mostly detectors for use in chemical analysis. One of these, the electron capture detector, first revealed the presence of pesticide residues throughout the natural environment. Some of his inventions have been adopted by NASA in its programme of exploring other planets.

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